MACHINERY

AUGUST, 1913

AN EFFECTIVE FOLLOW-UP SYSTEM*

A SYSTEM FOR RECORDING THE PROGRESS OF SMALL MANUFACTURED PARTS

BY A. L. VALENTINE

THE primary consideration in introducing new methods of management, is whether or not an adequate remuneration will be derived from the expenditure involved. Such remuneration may be either direct or indirect, but it must be sufficient to offset both the cost of introducing the new method and the operating and maintenance costs, and still leave the required margin of profit. When the project is of a size which involves a large outlay of money, it is obvious that the most careful study must be given to every detail of the proposed plan.

CUSTOMERS ORDER NO.	OUR ORDER NO.	NO. PIECES WANTED	KIND OF TOOLS WANTED	WILL FINISH DATE
1	2	3	4	5
FILLED IN BY OFFICE OR (STOCK DEPT.)	FILLED IN BY STOCK DEPT. BEFORE BEING SENT TO FOLLOW-UP DEPT.			FILLED IN BY FOLLOW-UP DEPT. AND RETURNED TO OFFICE WITH ORIGINAL LET. OF INQUIRY.

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Fig. 1. Form used to follow up an Inquiry Regarding Date of Shipment

It is the purpose of this article to outline a follow-up system which was recently developed by the writer for keeping an account of the materials used in a factory engaged in small interchangeable manufacture, and also of the progress made by different orders in passing from department to department in the course of manufacture. This new system was introduced to remedy certain evils that are likely to arise in any manufacturing establishment, and the writer was particularly fortunate in that he was not hindered by considerations of expenditure. This fact is mentioned because, had considerations of expenditure been carefully weighed before the benefits derived from the change had been demonstrated, it is probable that the new system would have been one of the many useful ideas "adorning the shelf," owing to the large initial and up-keep expenses. It may be mentioned that lack of perception on the part of the management is often responsible for discarding valuable ideas from failure to see the advantages which they possess, and unwillingness to bear the burden of what appear to be unreasonable expenses.

A B C D E

CUSTOMER ____________________

ADDRESS ____________________

CUSTOMERS NO.	OUR NO.	NUMBER AND KIND OF TOOLS WANTED	DATE SHIPPED
1	2	3	4

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Fig. 2. Card Index kept by Stock Department

* For articles on system previously published see: "System for Drafting Room, Office, Pattern Shop and Foundry," July, 1913; "Shop System," July, 1911, and other articles there referred to.

Before explaining the workings of the present follow-up system, it will be of interest to outline briefly the conditions which were responsible for bringing it about. As previously mentioned, this system was introduced through necessity and the same may be said of the changes which are made in many industrial establishments. When a factory is engaged in the manufacture of small tools or similar products, turned out in large quantities, a great many letters are received containing the vexing question, "When will you ship?" If these inquiries are not answered promptly and truthfully, the people waiting for the shipment of their orders will often be put to considerable inconvenience, as it is likely that they have planned and laid out their work with such promises of shipment in

100 200 300 400 500

ORDER TRACER

DATE OF ISSUE OF W.O. ____________________

NAME OF CUSTOMER ____________________

(IF STOCK—WRITE "STOCK" HERE)

ORDER NO. ____________________

PROMISED ____________________

DESCRIPTION OF TOOLS ____________________

NAME OF DEPT.	DEPT. NO.	LEFT THIS DEPT. DATE	MUST LEAVE THIS DEPT. DATE	REMARKS: REASON FOR DELAYS ETC.
CUT-OFF	1			
CHUCKING	2		BY LOOKING AT THE DATES IN THIS COLUMN ONE CAN ALSO SEE IF WORK HAS BEEN SENT TO CORRECT DEPT.	
TURNING	3			
MILLING	4			
INSPECTING	5			
HARDENING	6			
GRINDING	7			
INSPECTING	8			
	9			
	10			
DEPARTMENTS HERE GIVEN ARE IN THE SAME ROTATION AS MOST OF THE WORK TRAVELS.	GIVING EACH DEPARTMENT A NUMBER SAVES WRITING OUT THE NAME OF THE DEPARTMENT ON "DAILY REPORT", ETC.		THIS IS FILLED IN BY ROUTE CLERK AND IS A COPY OF ROUTE CARD GOING WITH W.O. DATES "MUST LEAVE" ARE NOT IN ROTATION AS THE WORK DOES NOT ALWAYS TRAVEL IN THE ORDER IN WHICH NAME OF DEPT. IS GIVEN IN COL. 1	FILLED OUT FROM FOREMAN'S REPORT TO SUPERINTENDENT BY FOREMAN SENDING THE WORK.
1	2	3	4	5

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Fig. 3. Order Tracer Card Index kept by Follow-up Department

view. If these promises are not kept, the orders will frequently be cancelled or repeat orders, at least, will not be received by the manufacturer. It was due to the distrust created among prospective purchasers, through giving evasive answers to inquiries about dates of shipment, and failure to keep promises, which led to the writer being given free hand to develop a follow-up system without being handicapped by considerations of the expenditure involved. This system is, with some modifications, in use in one of the largest factories of its kind in the United States, and after more than three years' experience, it has demonstrated its ability not only to remedy the evils which previously existed, but also to improve manufacturing conditions, so that the work of the sales department has been made far more efficient.

PROMISED

________ 19 ________

DATE	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.	W.O.
1																	
2																	
3																	
4																	
5																	
6																	
7																	
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30																	
31																	

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Fig. 4. Work Calendar showing Dates on which Orders must be finished

ESTIMATE AND ROUTE CARD

(MUST ALWAYS TRAVEL WITH ORDER IN ENVELOPE)

ORDER NO. ________________________

DESCRIPTION ____

CUSTOMER ____

NAME OF DEPT.	DEPT. NO.	ROUTE	MUST LEAVE THIS DEPT. DATE	ACTUAL DATE OF LEAVING DEPT.	REMARKS: REASON FOR DELAYS ETC.
CUT-OFF	1	1			
CHUCKING	2	2			
TURNING	3	5			
MILLING	4	4			
INSPECTING	5	6			
HARDENING	6	7			
GRINDING	7	8			
INSPECTING	8	3			
	9				
	10				
		WHEN OPERATION IS DONE SEND WORK TO DEPT. NEXT IN ROTATION.	FILLED OUT BY ROUTE CLERK FROM CAPACITY CARDS.	FILLED OUT BY DEPT. FOREMAN.	FILLED OUT BY DEPT. FOREMAN.
1	2	3	4	5	6

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Fig. 5. Estimate and Route Card which follows an Order through the Factory

Benefits of a Follow-up System

The benefits derived from this system may be briefly outlined as follows: (1) It enables the management to tell the date on which any order will be finished and ready for shipment, without having to go out into the different manufacturing departments, and with a minimum expenditure of time. (2) To systematically follow up all work—promised and unpromised—from one department to another, and thus receive warning of any delays or mishaps which may occur. (3) To tell at short notice in *which* department *any* order is at *any* time. (4) To tell at equally short notice how long an order has been in any department at a given time, thus making it possible to investigate causes of delay and take steps to remedy them. (5) To find out how many orders a department has on hand, thus making it possible to trace congestion and investigate the cause, *i. e.*, shortage of help, equipment, etc. (6) To afford a means of creating watchfulness on the part of department heads in regard to the time taken in the execution of orders.

As a result, it is impossible for men who are responsible for delays to avoid censure by such time-worn excuses as, "I did not understand it that way," "I mislaid the instructions," "I did not know," etc. As the foremen know that the follow-up system affords a sure method of placing responsibility for any hitch that may arise in the execution of an order, they are quite careful to make investigations on their own account before their superiors have been advised in regard to any delinquency that may have occurred in their respective departments.

To those who are intimately in touch with the details of operating a modern plant, it may seem that any follow-up system is a needless expense, especially if the goods manufactured are of a standard kind (not necessarily size). In most lines of manufacture, however, even standard articles consist of several parts, and in order to turn out the finished product these parts must be finished and made ready for the assembling department long before the supply of finished product has been exhausted. In such cases, a follow-up system is necessary for tracing the parts of the completed product through the different departments of the factory. Under these conditions, the system can be reduced to its simplest and most inexpensive form, its chief function being to follow up orders, consisting of a limited number of either parts or complete articles, finishing them before the supply is exhausted.

The system has its greatest usefulness, and is, in fact, an absolute necessity in establishments manufacturing small products of many sizes and many kinds, where a great variety of stock must be kept on hand at all times. It will also prove itself of more than ordinary value to an establishment where the departments have been grouped according to operations as is now nearly universally the case. The advantage of this method is that each department is run by an exeprt who operates the type of machines used in his department according to the most economical method, thus making them produce more and better work than would be possible if the product were made complete in a single department. The saving effected by this method is limited by the loss of time which is involved in moving the work from one department to another, in getting started in each department and by such necessary operations as counting, inspecting, etc. Where a factory is run on this method, without the use of an efficient follow-up system, it will not be long before trouble will be encountered from failure to keep promises in regard to shipment dates, through finding the supply of raw material suddently exhausted, etc.

Causes of Delay in finishing Orders

The most important features governing deliveries in any manufacturing plant are the stock and store-rooms for either finished parts or the complete product. Such being the case, it will be well to investigate some of the causes which are responsible for failure to supply these departments with goods in the required quantity and at the specified time. The causes may be outlined as follows: (1) Non-anticipation of large orders and the receipt of a number of small orders at the same time. (2) Shortage of raw material and failure to get in a fresh supply in time to meet existing requirements. (3) Failure to obtain additional equipment in time to meet existing requirements. (4) Lack of system in ordering stock, resulting in failure to issue orders to the factory in time to allow them to be completed before the stock on hand has been exhausted. The department having this work in hand should have intimate knowledge of the capacity of each department, as well as of the entire factory, so that it is possible to foretell exactly the amount of time required to complete any order which is issued. (5) Delays resulting from resetting automatic machinery to adapt it for a new class of work. (6) Delays caused by premium or contract systems where department foremen evade changing machines from one kind of work to another, in order to secure the greatest possible financial gains for themselves and their men. (7) Failure of the management to see the advantage of investing money in finished material, blanks, castings, and raw material. This condition is most pronounced in times of depression, which are best suited for "stocking up," as labor is cheapest at such times and manufacturing can progress unhampered by special orders that must be completed by a specified time.

DAILY REPORT

OF ORDERS HAVING TO-DAY LEFT THIS DEPT.

DATE ______________

NAME OF DEPT. ________________________________

NAME OF DEPT.	DEPT. No.	DATE OF PROMISE OF ORDER	ORDER NUMBER	ORDER SENT TO DEPT. No.	REMARKS
CUT-OFF	1				
CHUCKING	2				
TURNING	3				
MILLING	4				
INSPECTING	5				
HARDENING	6				
GRINDING	7				
INSPECTING	8				
	9				
	10				
1	2	3	4	5	6

________________ (DEPT. FOREMAN)

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Fig. 6. Form used by Foremen in making Daily Reports

Nearly all of these causes of delay were remedied in less than eighteen months by the follow-up system which was introduced by the writer. This was due to the fact that the system automatically calls attention to conditions responsible for delays, and keeps everyone from the manager and superintendent to the foreman and his assistant, informed of the conditions that have to be met in order for shipments to be made at a specified time. After a careful investigation of the causes of delay outlined in the preceding paragraph, it may be stated that the failure to keep an adequate supply of materials on hand is responsible for the greatest amount of trouble. The other reasons outlined suggest methods of avoiding them, so that little comment is necessary. It will prove worth while in the long run to keep a few surplus machines and a reserve quantity of finished parts, blanks and raw material on hand. This will make it possible to take care of large orders that come in unexpectedly or a number of small orders received simultaneously, without impairing the operation of the factory in any way.

The writer can see no excuse for any plant manufacturing a product for which there is a continued demand, not providing itself with a surplus supply of finished product. It is a conceded fact that the growth of any industry is dependent upon its ability to meet the demands of its customers, both as regards quality and prompt service. The customer scarcely considers whether his order is too large for your establishment or whether there are other orders on hand which must be filled before his receives attention. The result is that the factory which is able to fill orders promptly usually gets the business. The question of quality is taken for granted, and the manufacturer who neglects this feature will find himself unable to meet the keen competition that exists in practically all lines.

Value of Surplus Stock and Equipment

The preceding may be summarized by stating that in order to meet possible demands of customers for immediate delivery, one of two conditions must exist in the factory. The stock-room must either be well filled with finished product or finished parts of which the product consists, so that it is merely a matter of assembling them for prompt shipment, or else the factory must have an equipment large enough to take care immediately of large orders and finish them without delay. The first condition may be fulfilled by issuing orders to the factory in sufficient quantity and far enough ahead to enable the parts to be finished before the supply of stock on hand is exhausted. (The writer would suggest, in this connection, that when the supply on hand has been reduced to an amount equal to the number of pieces sold during any previous year, another order for an equal quantity should be issued immediately. The machine and tool equipment should also be large enough to produce such a number of pieces in a year.) While most manufacturers are willing to invest in reserve equipment, they are unwilling to keep a surplus stock of product on hand. It is reasonable to assume that the capital invested in extra equipment provided to meet emergencies is equal at least to

ROUTE CARD

COLLETS — #2 SCREW MACHINE

ALL SIZES COLLETS FOR THIS MACHINE TAKE SAME ROUTE;
ALSO ALL SIZES FOR #3 AND #4 SCREW MACHINE.

ROUTE	DEPARTMENT	No. OF DEPT.	REMARKS
1	CUT-OFF	1	
2	CHUCKING	2	
5	TURNING	3	
4	MILLING	4	
6	INSPECTING	5	
8	HARDENING	6	
	GRINDING	7	
	INSPECTING	8	
THIS MADE	COLUMN FILLED IN OUT IN CASE OF	— AND CAN CHANGE IN	BE CHANGED OR NEW CARD EQUIPMENT OR METHODS.
1	2	3	4

Machinery

Fig. 7. Route Card for Collets for No. 2 Screw Machine

that necessary for keeping a sufficient quantity of finished product on hand to meet such emergencies. In most cases, however, the capital invested in finished product is less than that required for a sufficient reserve equipment, and this advantage is further emphasized by the fact that shipments can be made immediately upon the receipt of orders, when the product is on hand in the store-room. In addition, the capital will be turned more rapidly, as it is not necessary to wait while the product is being made before it can be shipped on a given order. It seems scarcely possible that this fact can escape the attention of the management of so many manufacturing establishments, especially when the product so "stocked" can generally be produced at less expense than when made under average conditions. The solution is seemingly found in the fact that equipment does not show up on the books in the same way as finished product. In considering this subject, it should also be borne in mind that immediate shipment is a means of adding to the list of satisfied customers, who will send in repeat orders as the result of efficient service.

The Follow-up System

Having thus outlined some of the more important reasons for the use of a follow-up system, and the conditions over which it has control, the writer will describe a system which has many original features, and which has been proved to be more efficient than other systems coming under his observation. In order to make the explanation readily understood, certain minor details such as shipping and factory order forms will be omitted. Suffice it to say that the forms in general use for such purposes can be adapted to almost any system with satisfactory results. In starting upon an explanation of the workings of this system, it will be assumed that any inquiry as to the date of shipment of an order is received by the office. This inquiry usually carries the customer's order number, and is generally given a factory order number by which it is known until the order has been completed and shipped. The inquiry is immediately turned over to the stock department with the tag shown in Fig. 1 attached to it. The customer's order number is generally filled in by the office, but in certain cases where the customer's original order number is on file in the stock department, the tag is left to be filled in when it reaches that point.

ORDERS IN PROCESS —PROMISED

COLLETS—#2 SCREW MACHINE

SIZE	QUANTITY	ORDER NO.	DATE PROMISED CUT-OFF	CHUCKING	TURNING	MILLING	INSPECTING	HARDENING	GRINDING	INSPECTING		
½												
½												
½												
⅝												
⅝												
⅝												
¾												
¾												
¾												
⅞												
⅞												
⅞												

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Fig. 8. Capacity Sheet for No. 2 Screw Machine Collets

The stock department keeps a card index, of the form shown in Fig. 2, on which the factory order number is given opposite the customer's order number in cases where the goods are not in stock and have to be made. If no number appears on the card opposite the customer's order number, it signifies that the goods have already been shipped, the date of shipment being recorded in the column marked, "Date Shipped." If shipment has not been made, which is shown by the fact that no notation appears in column 4, and if no number appears in column 2 it shows that shipment can be made from surplus stock on hand. These cards are indexed according to names, and it will be noticed that one or more cards are used for each customer and that each card takes care of several orders.

CAPACITY SHEET—PER HOUR—PER DAY OF 10 HOURS

COLLETS #2 SCREW MACHINE

DEPARTMENTS	CAPACITY-SIZE ½	⅝	¾	⅞			REMARKS
CUT-OFF							
CHUCKING							
TURNING							
MILLING							
INSPECTING							
HARDENING							
GRINDING							
INSPECTING							

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Fig. 9. Sheet giving Record of Orders in Process of Manufacture

If the order is special (not in stock and not finished), the inquiry, with the tag shown in Fig. 1 attached to it, is immediately turned over to the follow-up department for answer in regard to the date on which delivery will be made. All of the columns on the tag, shown in Fig. 1, except the last one, have been filled out by the stock department, the date being taken from what is known as the shipping order which includes all details in regard to the items covered by the order.

The follow-up department refers to the order tracer card file, the form of which is shown in Fig. 3. These cards are filed in numerical order, one card being provided for each order number, and show the location of any order in the factory at any specified time. Consequently it is known how far the work has advanced, and also the date on which the work will be finished. A record is also kept on this file of any delay that has occurred, the department in which it occurred and the reasons for the delay, reference being made to the superintendent's "Reasons for Delayed Orders" file for this information. Every foreman is required to report to the superintendent at the end of each day's work in regard to every order which could not be finished and sent on to the next department as required by the schedule. When a department foreman receives an order, he marks the number of the order on his work calendar in the column opposite the date on which the operation must be finished by his department. One of these calendars, shown in Fig. 4, is generally hung up in the office of the foreman to afford him a means of looking ahead to make sure that all orders will be finished on time, according to the schedule laid out by the route clerk.

The date on which the work or operation must be completed by any department or foreman will be found on the "Route and Estimate" card shown in Fig. 5. These cards are filled out by the route clerk before the orders for the work are sent out to the factory, and follow the orders for the work from one department to another until the order is completed. These route cards not only show when each operation must be finished, but also the order in which the work is passed along from department to department, as shown in column 3. Re-

ferring to Fig. 5, it will be seen that after the chucking operation is completed in Department 2, the work must be sent to Department 5 for inspection, then to Department 4 for the milling operation, and so on until it is completed. Before the work leaves any department, the actual date of leaving is filled out on the route and estimate card by the foreman of the department. This is done at the same time that the daily report, shown in Fig. 6, is filled out, and the foreman receiving the work will be certain to report any errors in these dates to the follow-up department, if the route cards are dated unfavorably to him. This affords a method of checking the accuracy of the daily reports when they are being recorded on the tracer card file by the follow-up clerk.

The plan of having the foremen report any delinquincies or causes for failure to complete an order in accordance with the schedule, is one of the best guarantees that the work will be finished on time. As the superintendent is kept constantly in touch with the progress of each order by this method, he is able to take the necessary steps to prevent a constant recurrence of delays in any department, and this is largely responsible for the success which has been obtained from the use of this system.

With the data available through the records kept by this system, it is possible to answer inquiries in regard to the date of shipment immediately and with a reasonable degree of accuracy, without having to go out into the manufacturing plant for the purpose. It will be seen that the tracer card file, shown in Fig. 3, is the key to the whole situation. As previously mentioned, these tracer cards are made out before the orders go to the factory and are checked every day from the daily reports shown in Fig. 6. The route outlined on the route and estimate card, shown in Fig. 5, is, of course, an exact exact copy of the route card illustrated in Fig. 7 for the particular class of work which is being made. In this connection, it may be mentioned that the routes followed through the factory by many classes of work are practically the same.

Determining the Capacity of the Factory

The capacity sheet, shown in Fig. 8, although not directly connected with the follow-up department, plays an important part in the operation of the factory. These sheets show the capacity of each department for all the different operations which it handles. They are kept in a special loose-leaf binder, so that changes may easily be made in case of the addition of new machinery or methods in any department. The left-hand pages of the sheets kept in this binder enable the route clerk to determine the capacity of any department for a given operation at a glance, and the right-hand pages, shown in Fig. 9, give a record of all the orders in the factory that must be handled by the different classes of tools, the capacities of which are given on the capacity sheets. The dates on which these operations must be completed are recorded so that when a new order is isued an accurate estimate of its date of completion may be made.

The follow-up clerk checks the number of each order which has been passed on to a new department and the departments to which the work was sent from the daily reports, when checking up the tracer cards each morning. In so doing, he finds any discrepancy between the date on which the work was finished and the date when it should have been finished, according to the schedule. He may refer to the superintendent's file to obtain the reason in case of delay.

Although this system may be said to fill all of the requirements of following up the progress of orders through the factory, and keeping them moving according to schedule, it is lacking in certain respects. For example, how can a factory manager or superintendent determine the number of orders that a certain department has on hand at any time from a card index? How are such officials going to find out (without the assistance of a lot of clerical help and a lot of red tape) how long an order has been held in a given department? How are they going to know if promises are kept? For this purpose, the "Follow-up Rack" was designed, of which two sections are shown in Fig. 10, and which the writer believes to be an entirely new feature in follow-up systems.

This rack consists of twelve sections, one being provided for each month in the year, and is used to keep a record of progress of the work in the factory. A small card, of the form shown in Fig. 11, is made out at the same time that the estimate card is made out when an order is sent to the factory. Referring to Fig. 11, it will be seen that one side of this card has spaces for the order number, the name of the customer, the date on which delivery is promised and a description of the product called for by the order. The opposite side shows the different operations that must be performed on the work, the dates when the work should leave the different departments according to the schedule, and the actual dates upon which it did leave these departments. Fig. 12 shows both sides of the form of card used for stock goods. This card is of a different color from that shown in Fig. 11, which is used for special goods, and the customer's name is omitted. The reverse side is the same as that of the card described in connection with Fig. 11.

To illustrate the purpose of these cards, it will be assumed that Order No. 7001 is received from Jones & Co. for 500 collets on November 2, 1912. After the card is filled out in Column 2 by the route clerk, at the same time that he is filling out the estimate and tracer card, the clerk refers to the capacity sheet, Fig. 8, and to the promised order sheet, Fig. 9, to find if the order can be completed by January 28, which is the date specified for delivery. He then files the card in the 28th column of the January rack, opposite the department in which the first operation is performed. The card is then moved up

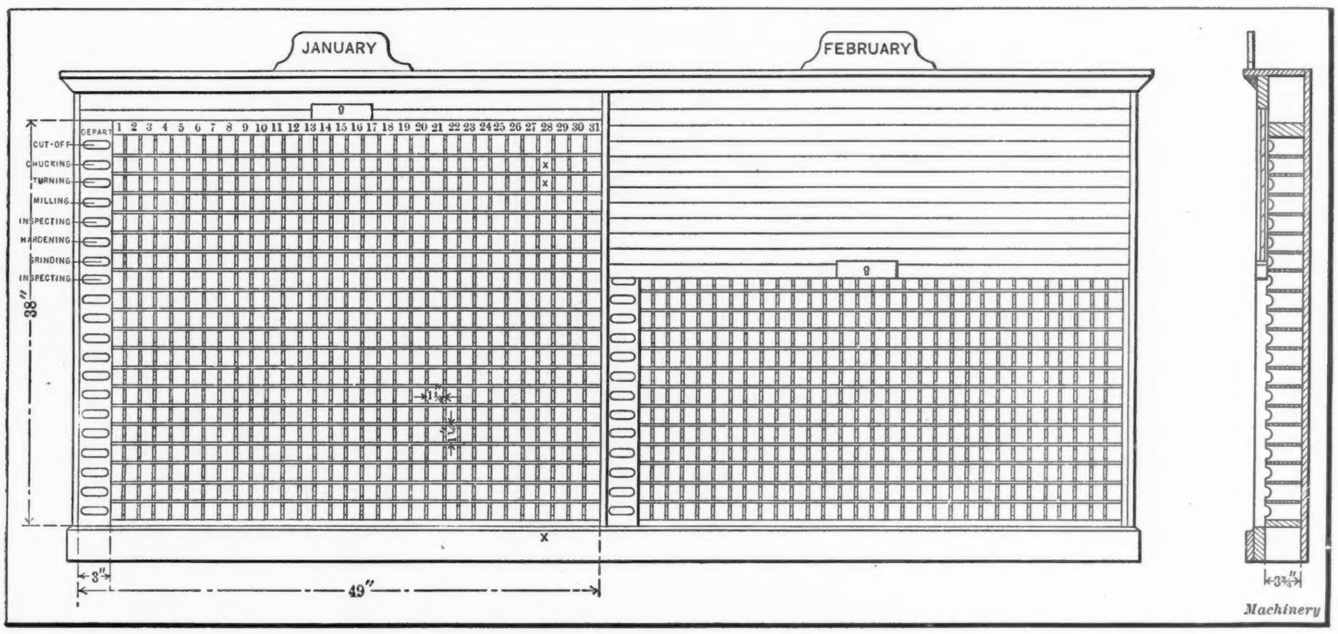

Fig. 10. Follow-up Rack which shows Progress of All work in the Factory

or down in this column, keeping it opposite the department to which the work has been transferred until the work is completed. The proper location for the card is found from the daily report, which not only indicates to which department the work has been sent, but also the date on which the order was promised for delivery. This enables the position of the card in the rack to be immediately found, and also the date on which it was promised for completion.

The card remains in the 28th column until the order is completed, after which it can either be thrown away or filed for future reference. This arrangement enables one to see at a glance just how many orders are promised to be completed, and if they are not finished on time this is immediately indicated by the appearance of the cards in the rack for dates already passed. This naturally causes everyone concerned to push the work along with all possible speed, and constitutes a gage of efficiency for both the department foremen and the follow-up department. This rack also makes it possible to look ahead, and if there appears to be any doubt in regard to a given order being unfinished by the specified date, there is ample time to take the necessary steps to avoid such a contingency.

All twelve racks are arranged in a single horizontal row, and by looking along the row it is possible to form an accurate estimate of how many orders a given department has on hand at any time, which could not otherwise be easily done. By looking at the back of the card, it is possible to see just when the work should have been completed in a given department, and when it actually was finished, the backs of the cards being filled out by the follow-up clerk from the daily reports sent in by the foremen. These data are especially valuable in cases where delay has occurred, as the department where the delay occurred can be instantly located without having to refer to the order tracer file.

It will readily be seen that the capacity records involve a good deal of expense, not only in getting them up but in keeping them up-to-date. It has been found however, that these records are an actual necessity, whether a follow-up system is used or not, and consequently this expense cannot justly be entered on the books against the follow-up system. The advantages secured through the follow-up system and

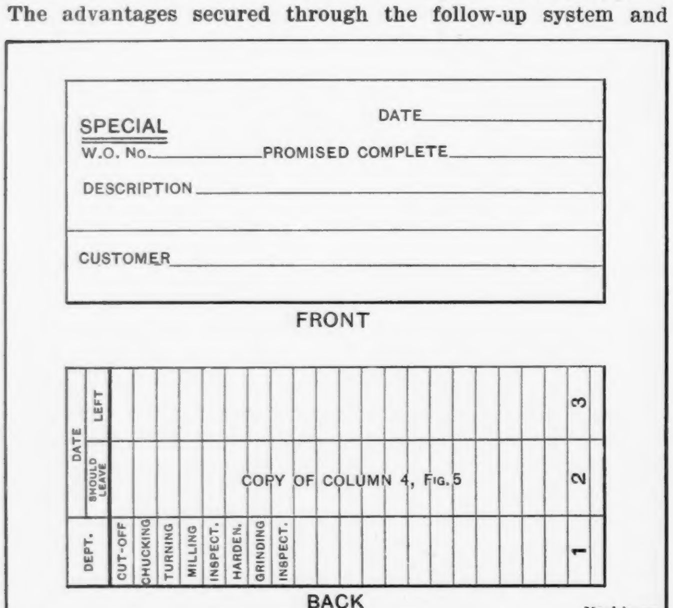

Fig. 11. Follow-up Rack Card for Special Orders

follow-up rack which have been described are far-reaching in their results. The heads of manufacturing companies have not generally much time for details, and the use of this system keeps them informed of nearly all the conditions in the plant that are of vital importance. Very little time is required to secure this information, and, best of all, they can determine just what these conditions are without spending valuable time in going about the factory. Figures and data are often misleading and errors or unintentional deceptions entering into the reports of subordinates are very frequently responsible for serious complications. Where this system is used, however, such deceptions are impossible and the management is thus protected from both deserved and undeserved criticism of customers, which leads to the loss of future orders. Hence, this follow-up system may be said to constitute one of the most

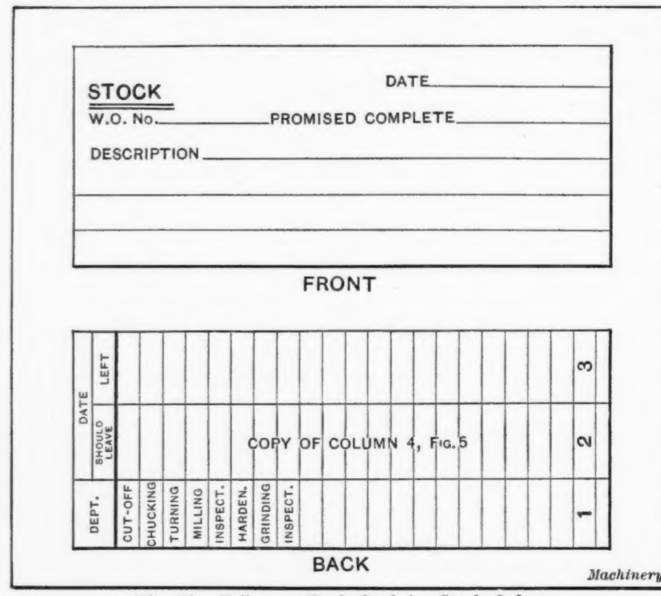

Fig. 12. Follow-up Rack Card for Stock Orders

productive non-productive departments in any manufacturing establishment.

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MACHINERY'S NEW HOME

The building where the offices of MACHINERY are now located is on a part of the new Court House site which has been taken over by the City of New York, and all the buildings thereon will soon be demolished. The Industrial Press, publisher of MACHINERY, has taken a twenty-one-year lease of the four top floors in the Bradstreet Building, corner of Lafayette

Bradstreet Building, Corner of Howard and Lafayette Sts., New York City

and Howard streets, a few blocks north of the present location, where the entire business will be moved in November. The new building, which is 90 by 115 feet, will be especially adapted to the requirements of the business, having light on three sides, and being close to the machinery center and to the various subways and surface lines. It will be fire-proof, of heavy steel construction, with brick and granite exterior, twelve stories high. MACHINERY's offices will occupy the top floor.

SPECIALIZED MACHINE TOOL EQUIPMENT

SPECIAL MACHINES USED BY THE HOEFER MFG. CO. IN THE MANUFACTURE OF DRILLING MACHINES

BY DOUGLAS T. HAMILTON*

The Hoefer Mfg. Co., Freeport, Ill., manufacturers of upright and special drilling machinery, has a number of special machines and fixtures that were designed particularly for performing certain operations on different parts of its drilling machines. Some of these machines incorporate in their construction interesting features which are worthy of description.

Special Machine for milling and drilling Machine Columns

In Fig. 1 is shown a special fixture applied to an ordinary engine lathe for turning the column of the 21-inch upright drilling machine. This fixture consists of a steadyrest *A* having a swinging cap and provided with a circular groove in which the circular end of the bracket *B* rotates. This bracket is screwed onto the nose of the spindle, and is provided with two projecting arms through which an arbor *C* passes, this serving to locate the column from the bearing caps. The column is prevented from slipping, and is also locked by two adjustable sleeves *D*, which are held by set-screws to the arbor *C*. The other end of the drill column *E* is supported on the tail-stock center in the usual manner. The column is turned down to the proper diameter with an ordinary lathe cutting tool, the fixture being the chief point of interest.

The special machine which is utilized for performing a series of operations on the drilling machine column after it comes from the lathe shown in Fig. 1 is illustrated in Figs. 2 and 3. In Fig. 2, which shows a front view of the machine, it can be

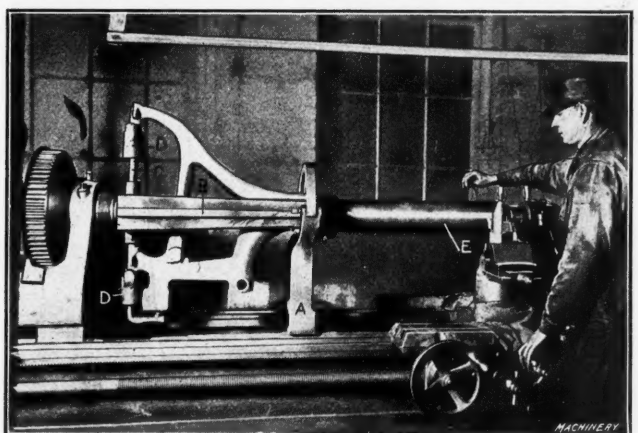

Fig. 1. Fixture used on the Lathe for holding Upright Drilling Machine Columns while turning

seen that the column *A* is clamped in bearings by swinging straps to an adjustable table *B*, and is held down on the other end by a strap *C* which is tightened down on this member of the column with sufficient pressure to hold it rigidly without springing it out of shape. The operations performed on this machine consist in splitting the lower spindle bearing, and cutting the clearance slot for the rack that is used for raising and lowering the drill spindle. The bearing is split by means of the milling cutter *D*, held and driven by a special attachment. This consists of a bracket *E* fitting on dove-tailed ways on the bed of the machine and provided with a projecting member machined to carry the cutter arbor and the mechanism necessary for driving it. This mechanism is more clearly shown in Fig. 3, where it can be seen that the power is received by a pulley *G* which ordinarily runs free until the clutch is thrown in by operating the handle *H*. This connects up the pulley with the shaft and drives the cutter arbor through a pinion and the large gear *I*. The bracket carrying this arbor is operated by power through a worm and worm-wheel shown at the right end of the machine in Fig. 3. The head can be also operated by the handle located on the end of the screw.

The clearance slot for the rack is cut in the lower spindle bearing by means of a broach *J*, shown in Fig. 2, which receives its oscillating motion through a connecting-rod *K* and the crank disk *L*. Power is received for the operation of this broach from the pulleys shown, which transmit power through the pinion and gear forming a part of this mechanism. The broach is carried and guided by a special bracket *M*, see Fig. 3, which consists of a sliding member that is operated inwardly by the ratchet feeding device *O*. As the broach is not held rigidly on the end connected to the crank, it is possible to feed it onto the work and still retain the correct alignment.

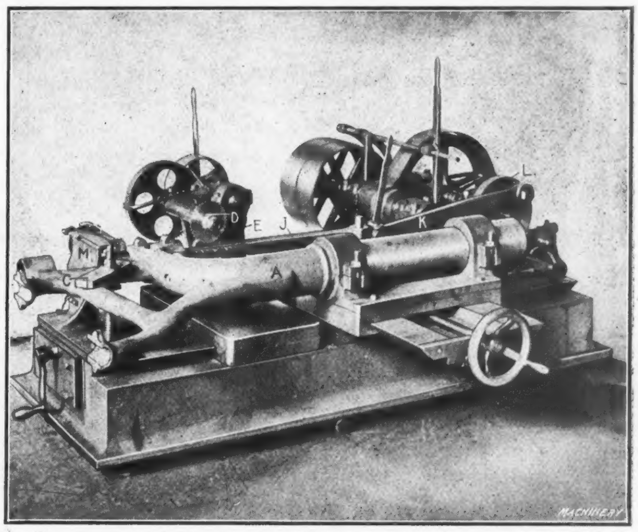

Fig. 2. Special Machine for milling and broaching Upright Drill Spindle Columns

The feeding is accomplished through a link and ratchet mechanism, which in turn receives power from the crank operating the broach. Both slitting and broaching operations are carried on at the same time.

Another type of special machine for performing milling and drilling operations on drilling machine columns is illustrated in Figs. 4 and 5. Fig. 4 shows what might be called a rear view of the machine, while Fig. 5 shows a front view. This machine is provided with five special heads, only three of which are used on this particular column. The head *B* which carries an inserted tooth milling cutter is used for milling the top faces of the caps. This head as illustrated, is driven by a pulley through gearing, and is fed longitudinally by a feed screw through the ordinary type of feeding mechanism. The head *C* is used for drilling the holes in the caps, and can be

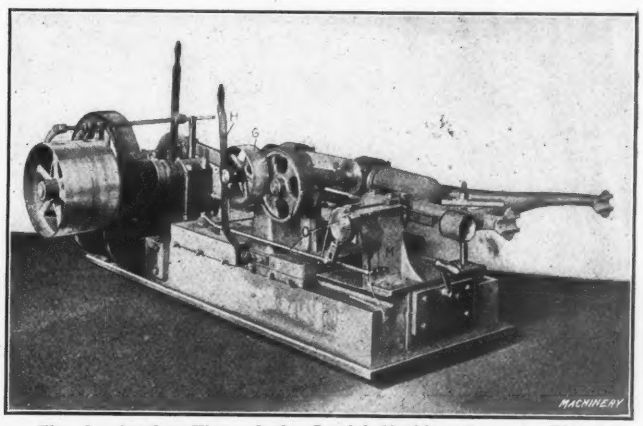

Fig. 3. Another View of the Special Machine shown in Fig. 2

moved into the required position by means of the hand wheels shown in Fig. 5.

The plates *D* carrying the bushings, swing on a pivot thus allowing the milling machine cutter to finish off these faces of the caps without removing the column from the fixture. The vertical head *E*, which is similar in construction to a regular drill head, is used for drilling and reaming several holes through the column, as indicated by the jig plates *F*. These plates are also hinged and can be thrown back in order to remove the work from the jig. Practically all of the milling and drilling operations are completed on this special machine without removing the column from the fixture once it has been set in place.

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Special boring and milling Machine

A special machine which is used for both boring and milling operations is shown in Figs. 6 and 7. In Fig. 6, this machine is shown at work boring the arm for the drill column. The machine consists mainly of a box-shaped column carrying a sliding head and a spindle used in holding the cutting tools. This spindle is driven from a countershaft attached to the machine, through a pinion and the large bevel gear shown. The downward feed for the spindle is obtained through a cone pulley *B* receiving power from the countershaft on the top of the machine, and transmits motion through spur gears and a worm and worm-wheel to the rack on the spindle. The fixture *C* used in holding the arm *A* consists of an iron casting provided with five projecting arms in which set-screws are inserted for holding the work, the latter being located by bosses in the jig. Before placing this arm in the jig, the cap is held on it by screw clamps as illustrated. The boring is accomplished with a fly-cutter retained in the holder of the spindle. One-quarter inch of material is removed from the diameter of the bore with a roughing and finishing cut. The finished diameter is 5½ inches and the length of bore is 8 inches. The bore is chambered for 3½ inches of its length and the time required to complete the operations mentioned is ten minutes.

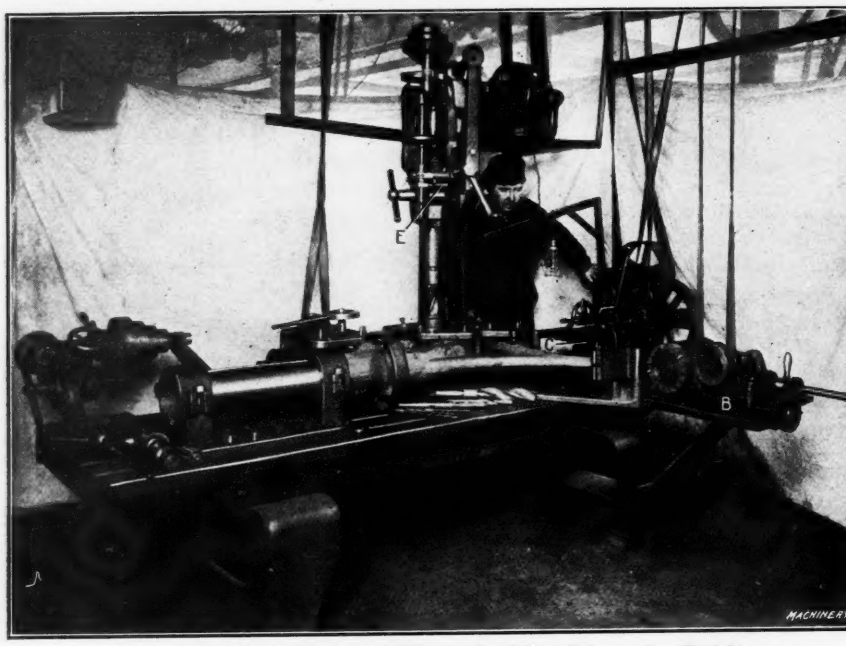

Fig. 4. Special Machine for drilling and milling Columns for Upright Drilling Machines

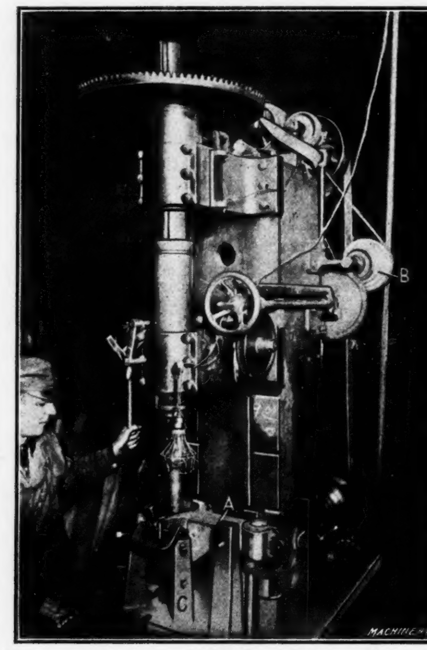

Fig. 6. A Boring and Milling Machine set up for boring the Arm used in holding Drill Tables

In Fig. 7 the machine shown in Fig. 6 has been converted into a vertical milling machine simply by the addition of the milling cutter on the spindle instead of the fly-cutter, and the unlocking of the table *C*. The work *A* which is handled in this illustration is a sliding head for a drill press, the operation consisting in milling the 45 degree bearing surfaces that fit on the corresponding projections on the column of the sliding head tpye of upright milling machine. The cutter *B* is provided with high-speed steel inserted teeth and removes ⅛ inch of material from each side. The length of the surfaces milled is 10 inches and two cuts are taken—one from each side. The cutter is set in the desired position by steel buttons which are inserted in the jig. When performing this operation, the vertical spindle of the machine is firmly locked. Power is transmitted to the table *C* carrying the fixture *D*, in which the work is located, through the regular type of feeding mechanism which is operated from the countershaft arrangement on the top of the machine through bevel gears and a worm and worm-wheel. The time for completing the milling operation on one sliding head in the planer is two hours, and the heads are held on the table in gangs. In Fig. 7 only one sliding head is held at a time, but the actual machining time is only 37 minutes—almost one-quarter of the time required on the planer.

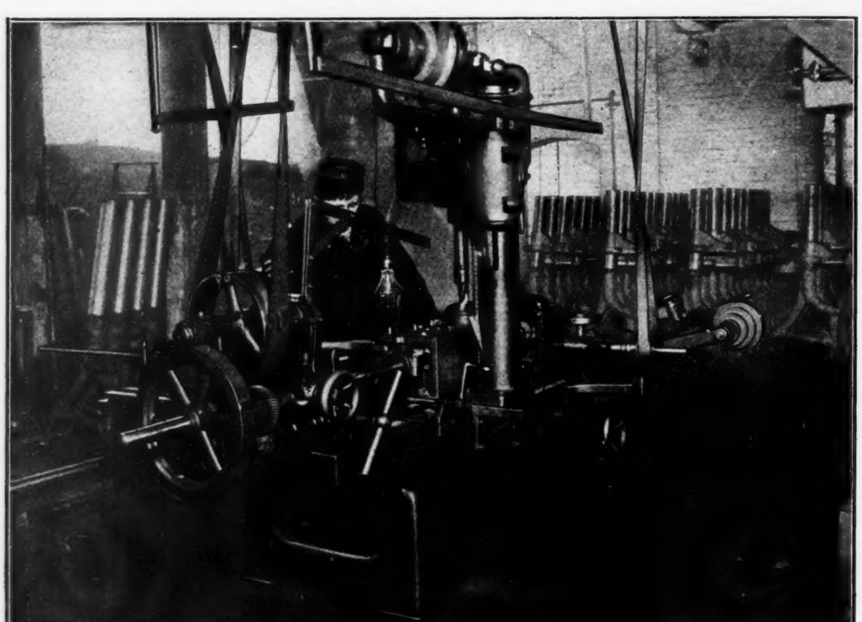

Fig. 5. Another View of the Special Machine shown in Fig. 4

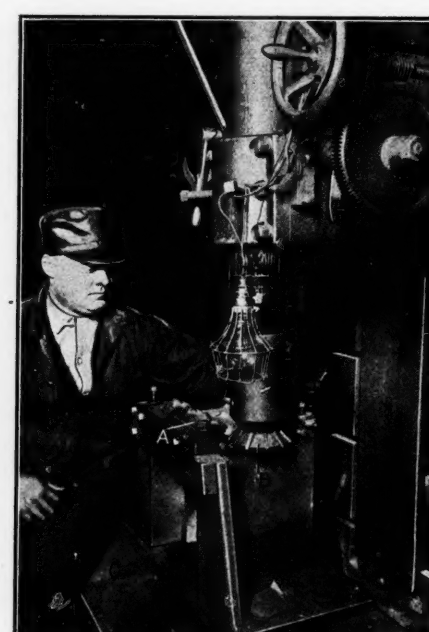

Fig. 7. Machine shown in Fig. 6 for milling the Sliding Head of Drilling Machines

Machine for grinding the Crown on Cone Pulleys

The cone pulleys which are roughed out in an engine lathe are brought to the special machine shown in Fig. 8, where the crown is ground to produce a smooth surface quickly. This special machine is designed on the principle of a lathe, the work being held on an arbor on the centers and driven by a dog in the usual manner. Attached to the bed of the machine

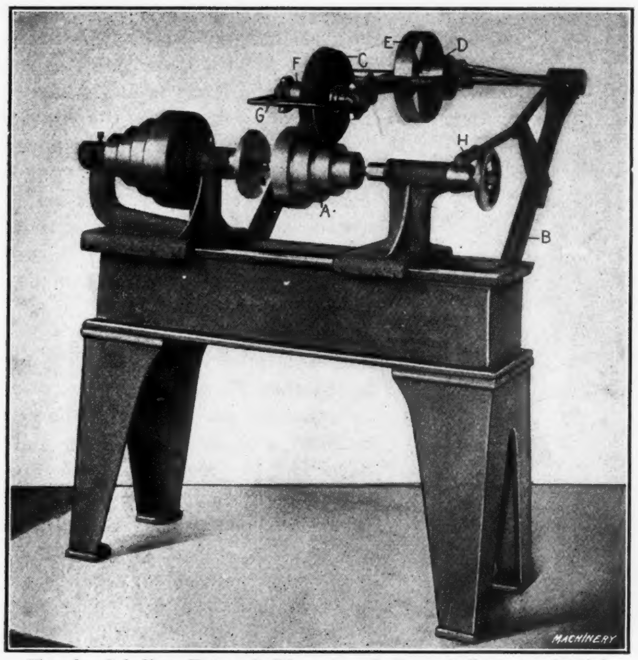

Fig. 8. Grinding External Diameter of Cone Pulleys in Special Machine built for that Purpose

is a bracket *B* carrying a countershaft and also an arm in which the grinding wheel *C* is held. Power is obtained from a countershaft, not shown, to the pulley *D* and from this by a belt running on pulleys *E* and *F* to the grinding wheel *C*.

The manner of operating this machine is as follows: The operator grips the handle *G* with his left hand and handle *H* with the right hand. Then by means of handle *G* he keeps the

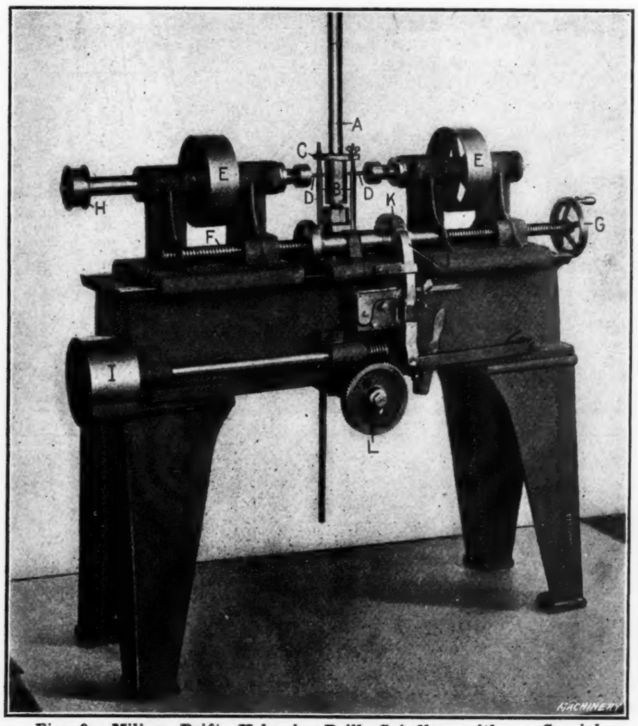

Fig. 9. Miling Drift Hole in Drill Spindles with a Special Two-head Milling Machine

wheel in contact with the step of the cone pulley that it is desired to grind, and at the same time operates the handle *H* which transmits a longitudinal movement to the attachment carrying the grinding wheel. The pulley *A* at the same time is rotated by a belt running on the cone pulleys of the machine.

Machine for drilling Drift Slot in Drill Spindles

The special machine used for milling the drift slot in drilling machine spindles is shown in Fig. 9. The drill spindle *A* is held down on a taper arbor fitting the hole in the spindle by two arms *B* and a swinging clamp *C* that rests on the shoulder of the drill spindle. The slot is cut by two end mills *D* held in chucks as shown and rotated by belts running on pulleys *E*. The heads carrying the end-mills are operated (or brought together) by a right-hand and left screw *F*, which can be operated either by a hand-wheel *G* or by power. The power feed for the end-mills is accomplished as follows: Pulley *H* is belted to a pulley *I*, which through the worm and worm-wheel shown at the front of the machine and through a cam on the worm-wheel hub, operates the ratchet pawl *J*, this engaging with the ratchet wheel *K* on the feed screw and rotating it automatically to feed the end-mills into the work. The worm-wheel *L*, through a gear and rack, also transmits a vertical movement to the chuck carrying the drill spindle and in this manner enables the drift slot to be milled elongated.

* * *

THE OPEN SHOP

This is not on the open shop as defined by labor unions, in which many believe and others see a menace. It is on the open shop in which all mechanics who like to see their trade prosper and progress, believe. Recently, in a Massachusetts city prominent in manufacture, we saw the following sign over an entrance to a machine shop:

FACTORY.

You are invited to visit our factory. We have original and improved methods, but no secrets. We take pride in our excellent equipment and experienced mechanics. We want you to know the reason for our quality. Ask to be shown.

The sign is the more remarkable as this particular factory is engaged in a manufacture about which, in many places, extreme secrecy prevails; and yet with their doors open to all visitors and their methods and processes freely shown to any caller, this factory maintains a standard apparently above that of many of its competitors. It does not depend on a few cherished trade secrets (which are more than likely known anyway to anyone well versed in the trade), but seems rather to depend upon the personnel of its organization, the intelligence of its employees, and its broad and liberal policy towards its competitors, for the success that it enjoys. A business built up on a few trade secrets rests on flimsy ground. Any day someone may leave the concern and carry off all the secrets; but a business that is built on no secrets and yet maintains a standard of manufacture equal or superior to that of its competitors, is built on so firm a foundation that it need not fear that an occasional visitor is going to steal its "secret of success."

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AN IMPROVED METHOD OF METAL SPINNING

The trade of metal spinning is generally recognized as one which requires considerable skill on the part of the operator and a large amount of physical strength. The latter condition is so marked in spinning the larger sizes of work that belts or other devices are attached to the spinning lathe to afford a brace for the operator in order that he may apply his full weight on the forming tool. Needless to say, this work is extremely fatiguing and is likely to bring on liver trouble and other physical disorders.

Fig. 1 shows a view in a German metal spinning shop. In this illustration, workman A is using the old-fashioned equipment in which the method of providing a belt for him to lean against is clearly shown. Workman B is using an improved form of equipment which is the invention of Hermann Rahn of the Siemans-Schuckert Works (an electrical manufacturing company in Germany, which compares in importance with the General Electric Co. in America). The characteristic feature of this equipment lies in the fact that the forming tool is fulcrumed in such a way that it is not necessary for the workman to apply an excessive amount of physical strength in the performance of his work. The average man is able to provide ample pressure with his arms, it being unnecessary to throw the weight of his body against the work. Consequently, he is able to stand in a natural position in front of his lathe and is not excessively fatigued. A second advantage

of the equipment is obtained through the provision of a mechanical guide for the outer edge of the work. This guide is held in contact with the work by a spring and prevents the outer edge of the disk from vibrating. As the operator is not required to hold his hand close to the edge of the rotating

Fig. 1. Old and Improved Methods of Metal Spinning

disk, the danger of his being badly cut is eliminated. As a result, a scarred left hand need no longer be regarded as characteristic of the metal spinning trade.

Fig. 2 shows a detailed view of this improved spinning apparatus. Referring to the illustration, it will be seen that the work is clamped to the spindle by a suitable nut, the usual type of form being used to secure the desired shape for the work. It will be seen that there are two hand levers on the apparatus. The left-hand lever may be screwed into any one

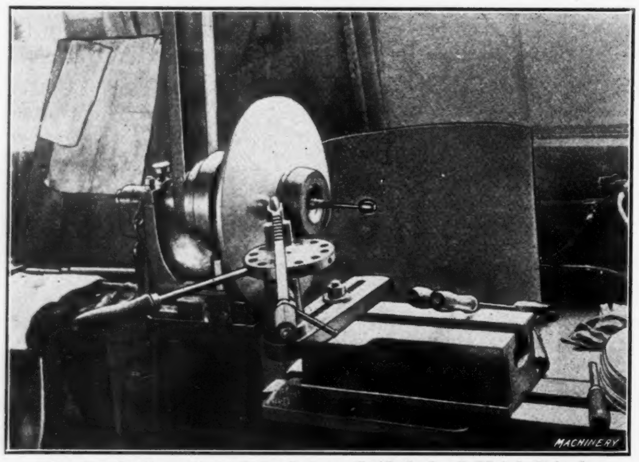

Fig. 2. Equipment used in Improved Method of Metal Spinning

of the threaded holes which are seen around the edge of the disk. This disk is pivoted on the vertical support so that it may be rotated by means of the lever previously referred to, to bring the forming tool into the desired position. The right-hand lever has the forming tool mounted on it. It will be seen that this lever is provided with a series of notches, these notches being used to fit over a pin in the forked support which carries the lever. The idea of this is to provide for the disengagement of the lever from the support in case the tool catches in the work. The forked support may be pivoted in either of the holes shown around the periphery of the disk, and by adjusting its position in these holes and putting a suitable notch in the lever over the pin in the support, the forming tool may be brought to practically any desired position in relation to the work. The position of the operator is clearly shown in Fig. 1. By means of the two levers he is able to make the tool follow any desired line, and also apply the required amount of pressure to the work. The support for the guide used to steady the outer edge of the disk is shown in Fig. 2. This view is incomplete, however, as a sliding member which is held in contact with the work by a spring carried in the support, is not shown here.

At least three months is required to teach a man the metal spinning trade, if the old type of equipment is used. After such a period of training he still has a great deal to learn, as the trade is one which requires a considerable amount of judgment and dexterity on the part of the operator. Using the form of equipment described in this article, a man can be taught to do satisfactory work in a period of time ranging from a few hours to two days at the utmost. Furthermore, he is able to turn out more work and to handle heavier classes of work than is possible where the old method of spinning is used. Fig. 3 shows a number of examples of spun metal parts and by referring to this illustration, in connection with the table, a good idea of the relative output of a skilled man using the old-fashioned equipment and that of an unskilled man using the Rahn equipment, will be readily appreciated. The sale of this apparatus is being handled by Eugene Eichel, Charlottenburg 4—Berlin, Waitzstrasse 7, Germany.

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A large manufacturing concern in Bridgeport making small electrical devices has found that small taps with rolled threads

WAGES PER 100 PIECES AND TIME OF PRODUCTION

No.	Wages per 100 Pieces in Marks		Time per Piece in Minutes		No.	Wages per 100 Pieces in Marks		Time per Piece in Minutes	
	Of Skilled Men	Of Unskilled Men	By Skilled Men without Apparatus	By Unskilled Men with Apparatus		Of Skilled Men	Of Unskilled Men	By Skilled Men without Apparatus	By Unskilled Men with Apparatus
1	53	18	40	15	10	110	40	75	35
2	50	20	40	17	11	45	15	35	12
3	25	10	20	8	12	15	5	12	4
4	30	10.50	25	6	13	100	35	75	30
6	15	6	12	5	15	45	18	35	15
7	18	7	17	6	17	35	9	25	8
8	16	7	15	6	18	15	5	12	4
9	100	30	75	25	20	70	10	55	8

Machinery

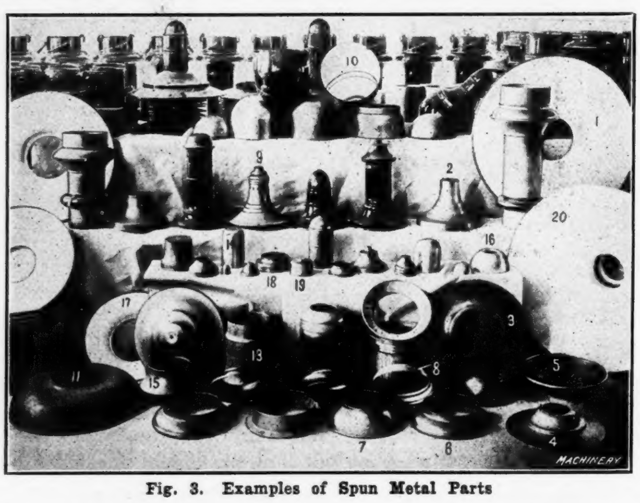

Fig. 3. Examples of Spun Metal Parts

will retain their size five times as long as ordinary taps threaded and finished with regular thread cutting tools.

KNOCK-OFF ARBORS FOR THREADED WORK

ARBORS ADAPTED FOR VARIOUS OPERATIONS WHICH ILLUSTRATE PRINCIPLES OF DESIGN

BY ALBERT A. DOWD*

There are numerous instances in the manufacture of parts for interchangeable work, where a certain portion of the particular piece in question must be absolutely true and concentric with a thread which has been previously cut upon the other end. Sometimes an external thread has been chased or possibly cut with a die-head, while in other cases an internal part may have required the use of a tap to cut the thread. Occasionally both ends are threaded and must be concentric. Taper or pipe threads are found at times on a variety of work, and they also may be obliged to conform to the same conditions. On some pieces the end adjacent to the threaded portion is left unfinished, which increases the difficulty in handling for any subsequent operations which may be necessary in the production of the work.

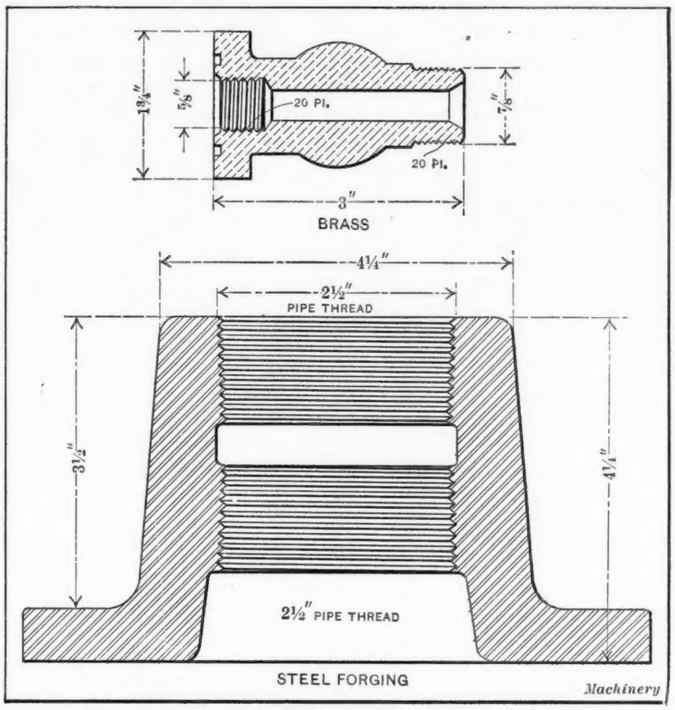

Fig. 1. Examples of Work handled on Knock-off Arbors

The machine tools available for the work being of various types, and the work itself of widely different forms, obviously bring about the design of holding devices to meet the particular requirements of each condition. The horizontal turret lathe is probably more frequently used for this class of work than any of the other machines, although the shaving machine or short bed facing and turning lathe is also decidedly adapted to some operations. Our good old friend, the engine lathe, is frequently called upon in an emergency or otherwise, while the vertical boring mill and the vertical turret lathe are used somewhat less frequently.

The work may range in size from a piece like the small brass pressure valve body shown in the upper portion of Fig. 1, up to the large steel boiler nozzle in the lower part of the same drawing. Larger pieces than this, and possibly still more difficult to handle, may be met with occasionally, but the fundamental points will be the same and will require the same methods of machining.

Elementary Design of Arbors

Let us take the simplest condition possible, for example, the threaded collar shown at *A* in the upper part of Fig. 2, in which it is only necessary to face the end *B* so that it will be square with the thread. A plain arbor such as that shown, with a shoulder against which the collar may be screwed, seems to meet the requirements of this case. But after the end has been faced, it is highly desirable to be able to remove the piece and put on another, and here lies the difficulty, for the wedging action at *C*, caused by the slight twisting of the work under the strain of the cut, has tightened the collar to such an extent that the assistance of a pipe-wrench (or some other method which may suggest itself) is needed before the work can be started. Even after this has been done it will be found that the outer surface is considerably injured.

The arbor shown in the central illustration, Fig. 2, is a refinement of the first, in that the check nuts *D* and *E* permit the easy removal of the piece after the work has been accomplished. No longitudinal stop for these nuts is provided, however, and therefore the length *F* is susceptible to variations, unless each piece is carefully measured to obtain the correct length while facing.

The lower arbor shown in Fig. 2 overcomes the faults found in the two others and for lathe work it answers the purpose for which it is intended. The work *G* comes to a positive longitudinal stop against the face of the collar at *H*, and the collar itself has a fixed location in the shoulder *J*. A left-hand thread is provided on the arbor at *M*, and this effectually resists any tendency to unscrew, as the action of the tool upon the work is in the right direction to force it into this position. It should be noted that the two lugs *K* and *L* are integral with the collar, and forged as shown. After the machining operations have been completed, the work is released by a sharp blow with a babbitt hammer or a billet of wood, on either of the two lugs.

In designing an arbor of this type, remember that the left-hand thread for the knock-off portion should be of very much coarser pitch than that of the work itself, because the wedging action is much less in the coarser pitch thread, and consequently the releasing may be more readily accomplished. A ratio of 1 to 2 is usually sufficient. For example, if the work is threaded 20-pitch right hand, it is advisable to thread the knock-off 10-pitch left hand or even coarser if desired.

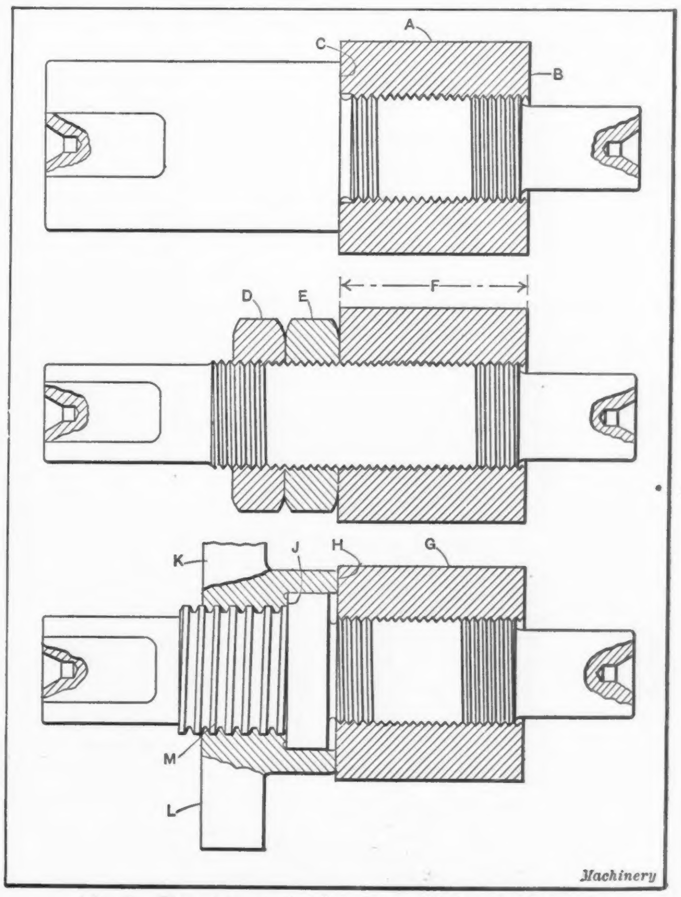

Fig. 2. Three Types of Arbor for machining the Piece A

The following are three important points to be observed in the design of arbors of this type:

First: Positive longitudinal location of the work.

Second: Means for minimizing wedging action and at the same time allowing quick and easy release.

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Third: Construction of the arbor in such a way that no chance for springing out of truth is possible.

Arbors for Small Work

A small piece requiring a knock-off arbor, is the brass valve body shown in the upper portion of Fig. 1. In this case it was necessary that the threaded portions should be concentric and true with each other, and it was not practical to make the piece from the bar, complete in one setting. The arbor

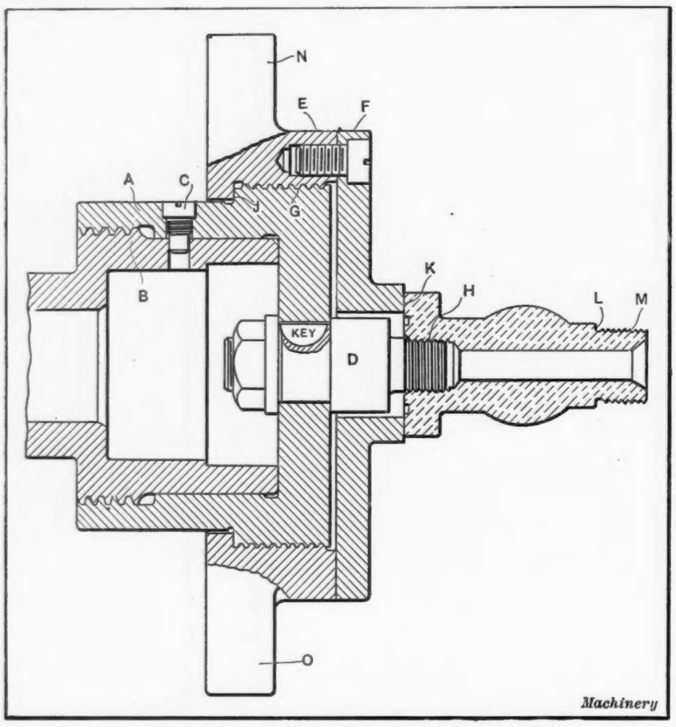

Fig. 3. Arbor for machining Valve Body shown in Fig. 1

shown in Fig. 3, was applied to the spindle of a small turret lathe, and a Geometric die-head mounted on the turret, was used to cut the thread. The construction of the arbor was as follows: A special nose-piece *A* was mounted on the end of the spindle *B*, and a retaining screw *C* prevented it from unscrewing. The screw arbor *D* was keyed in position and drawn back firmly against the nose-piece by the nut shown. The knock-off portion in this instance, was (for assembling purposes) made in two pieces *E* and *F*, these being held together by three

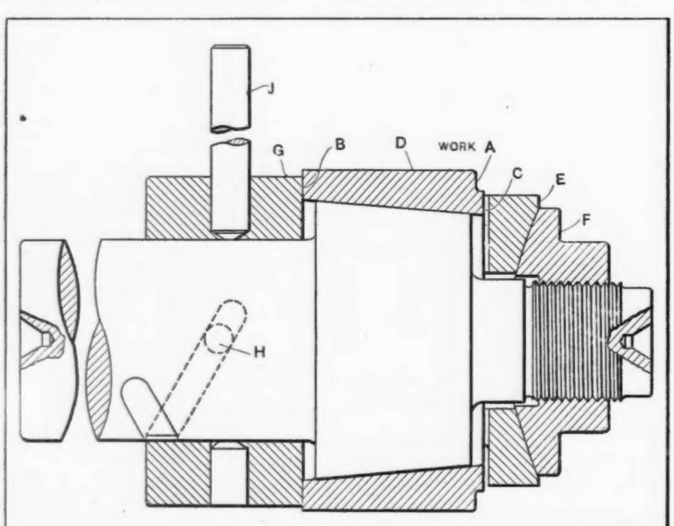

Fig. 4. Male Type of Knock-off Arbor

screws 120 degrees apart. The threaded portion of the work, shown at *H*, was 20-pitch right hand, while the knock-off, at *G*, was made 8-pitch left hand in order to minimize the wedging action and make releasing easier. In using this arbor, the knock-off was brought up against the shoulder *J*, which constitutes the positive stop, and the work screwed on at *H*, the end bringing up firmly on the ring at *K*. The shoulder *L* and thread *M* were then machined in their correct relation, by turning and threading tools located on the turret. To release the work after the machining had been accomplished, a sharp blow with the babbitt hammer on either of the two lugs *N* or *O* was all that was necessary. After this the work could be readily unscrewed by hand.

Fig. 4 shows a knock-off arbor which is not used for threaded work, but its construction is along the same general lines and brings in some of the same principles, so that it is included in order that the salient features of its design may be noted. The conditions responsible for its design are somewhat peculiar, in that a taper hole—$\frac{1}{8}$-inch taper per foot—has been reamed in the work *A*, and as this piece was made from the bar on a screw machine and then cut off, it is obvious that while the end of the work *B* is approximately square with the taper (as it is faced at the same setting) the other end *C*, where the piece is cut off, will very likely be out of truth. The purpose of the arbor was to hold the work while refinishing the surfaces *D*, *B*, and *C*, so that they would run in perfect truth with the taper. The cup-shaped collar *E*, having a three-point-bearing against the work, is held in position by the ball-nut *F*, thereby avoiding any cramping action that would tend to distort the arbor. This nut is released, after the periphery has been turned and the end *B* faced, so that a cut may be taken across the face *C*, thus finishing the piece. As the tapered portion is of such an angle that the wedging action is sufficient to hold the work firmly, no trouble in

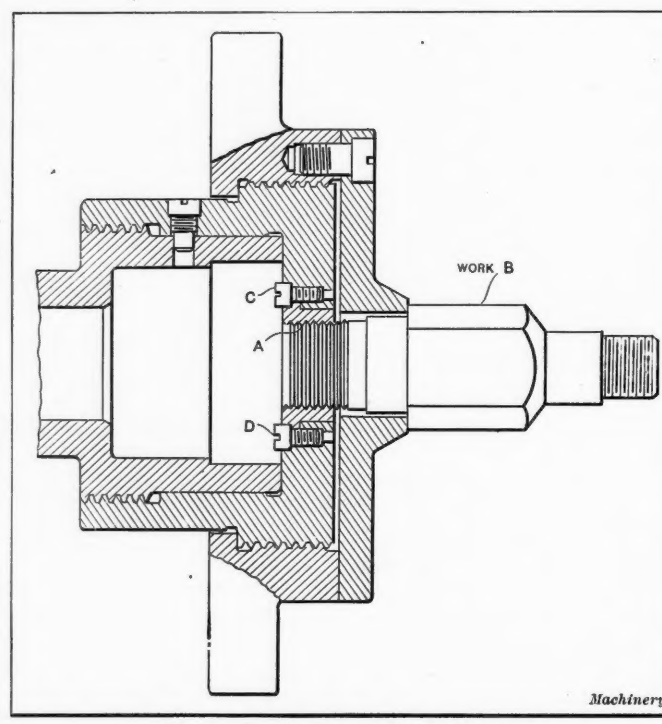

Fig. 5. Female Type of Knock-off Arbor

the matter of driving is experienced, but in removing the work from the arbor, the knock-off collar *G* is brought into use. This collar has an internal pin *H*, working in the right-hand spiral slot shown. The end of the rod *J*, removable at will, acts as a lever by means of which the collar is operated, thus forcing the work from the arbor.

Fig. 5 shows a female arbor of somewhat similar construction to the male arbor which has been noted in Fig. 3. In this case the threaded bushing *A* receives the end of the work *B*. The bushing itself is held in place by the two screws *C* and *D*, but aside from this difference, the arbor is about the same as the other.

An Unsuccessful Knock-off Arbor

It is fully as important, in designing any piece of mechanism, to understand what not to do, as it is to know just what to do. For this reason, an instance is given of an arbor which was not successful, partly because of careless handling when in use on a turret lathe, but chiefly on account of faulty design. The arbor, shown in Fig. 6, was designed for the purpose of turning and facing milling machine arbor nuts, and it was intended to take care of nuts from $\frac{3}{4}$-inch up to and including $1\frac{1}{2}$-inch thread diameter, and of various lengths. The body *A* was made of tool steel, hardened and ground to

fit the spindle ring of the turret lathe, and it was drawn up against the shoulder *C* by a rod *B* passing completely through the spindle *D*. The slot *E*, which is tapered on the rear end, receives the knock-out wedge *F*, and this in its turn, bears against the slip-collar *G*. The screw-arbor *H*, shown also in detail in the upper left-hand portion of the illustration, was

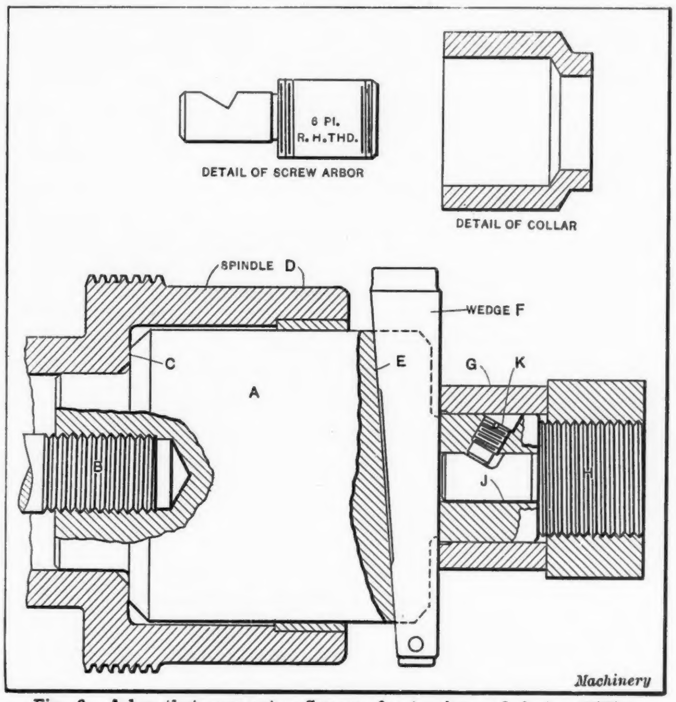

Fig. 6. Arbor that was not a Success for turning and facing Milling Machine Arbor Nuts

a ground fit in the cylindrical hole *J*, and held in place by the screw *K*. The slip-collars and threaded arbors, shown in detail, were made in various sizes and pitches to suit the nuts which were to be handled. This entire equipment was unsuccessful, and its use was discontinued after attempting in every way to ensure its truth. Although all the parts were very carefully made and fitted, there were certain inherent faults

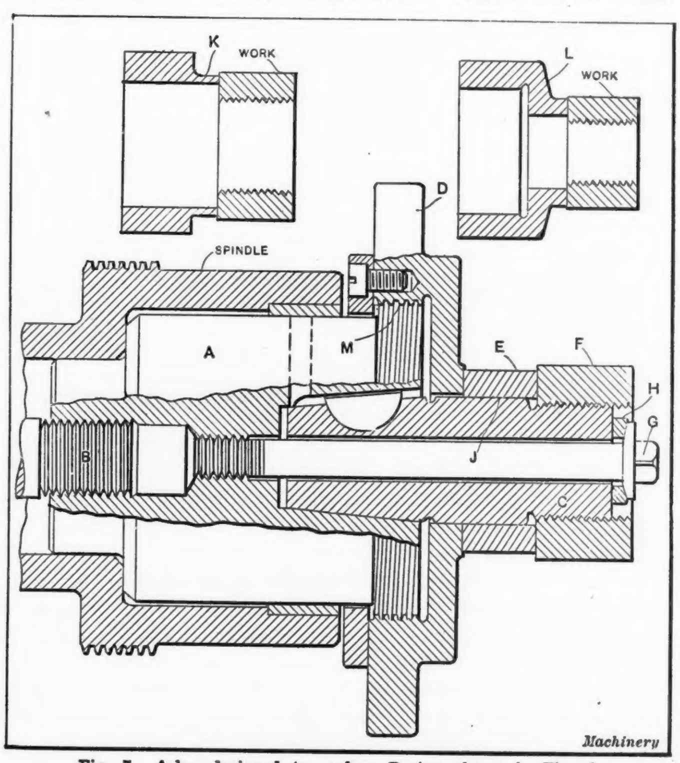

Fig. 7. Arbor designed to replace Design shown in Fig. 6

in the design which could not be remedied. After the work had been placed in position and the wedge tapped lightly to make sure that it was firmly seated, it was noted that there was frequently a decided wobble at the end of the arbor, which should obviously have run in perfect truth. Undoubtedly the action of the wedge had a tendency to throw unequal strains upon the structure, while the screw *K* also helped the matter along, so that the whole arbor was faulty in these particular points, and it was therefore considered a failure.

The Successful Design for the Same Purpose

A decidedly improved construction for the same purpose is shown in Fig. 7, although its cost was considerably greater than the other. The body *A* in this arbor was located and secured in the spindle in the same manner as the other, *i. e.*, by a threaded draw-back rod *B*, running through to the rear end of the spindle. Every precaution was taken to ensure a true running arbor, all essential points and surfaces being ground or lapped in position, in order to avoid all chances for error. The threaded interchangeable arbor *C* was accurately fitted to the conical hole in the body, and was keyed to resist the torsion of the cut. As in a previous instance the knock-off portion consisted of two parts, shown at *D*, in order to permit assembling while the thread at *M* was 6-pitch left hand thus making removal easy. *E* is an interchangeable sliding collar, and it interposes between the shoulder of the knock-off and the work *F*, obviously acting as a spacer and longitudinal stop at the same time. The ball and cup arrangement of the bolt and washer *G* and *H* serve the purpose of obviating any tend-

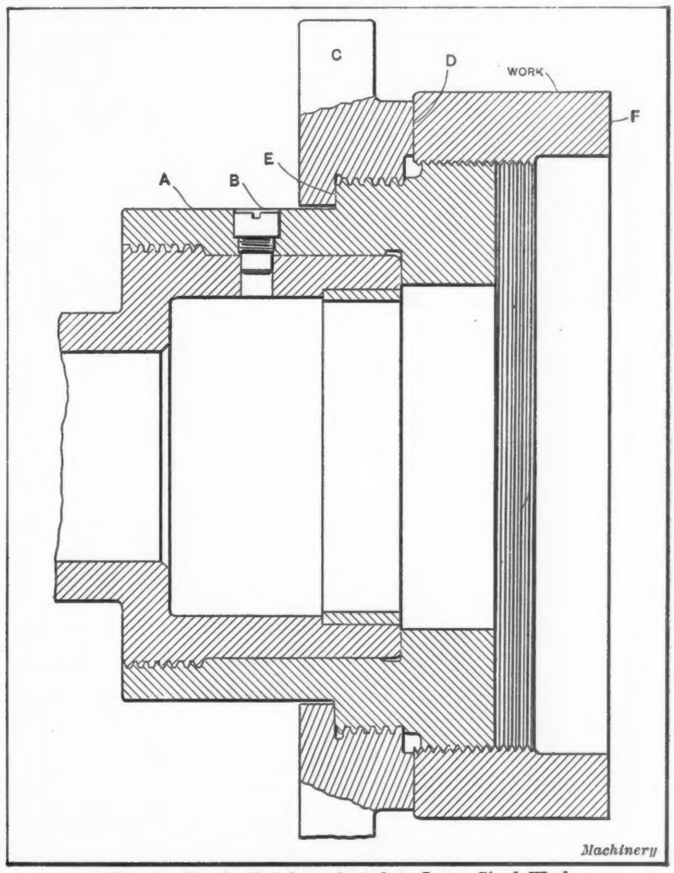

Fig. 8. Knock-off Arbor adapted to Large Sized Work

ency to "cock" the arbor when it is placed in position. To obtain as rigid a construction as possible, the taper is of generous dimensions and the cylindrical portions of the various arbors are made uniform in size. By referring to the upper left-hand illustration in Fig. 7, it will be noted that the collar *K* is shouldered for a short distance back of the work, to allow the turning tool to perform its function. For some of the smaller sizes a collar like *L*—upper right hand—was found necessary, due to the difference in the shoulder diameters between *J* and *C*.

Arbors for Larger Work

When the work is as large as that shown in Fig. 8, a somewhat different construction is necessary. In the case shown, the piece is a threaded steel collar 7½ inches in diameter, in which the end *F* is to be faced square with the threaded portion. This arbor is applied to the spindle of a large horizontal turret lathe, and its use is obviously restricted to work of a diameter somewhat larger than the turret lathe spindle. The body *A* is screwed directly onto the spindle as a face plate would be, and it is prevented from turning by the teat screw *B*. The knock-off portion *C* is threaded with a 4-pitch left-hand thread of the Acme type, running on the body portion and

naving the usual projecting lugs for releasing purposes. As it brings up against the shoulder *E*, it forms a positive stop for the work, which locates on the ring at *D*. The action of this arbor is very evident, while its extreme simplicity, it being composed of only two parts, makes it one of the best.

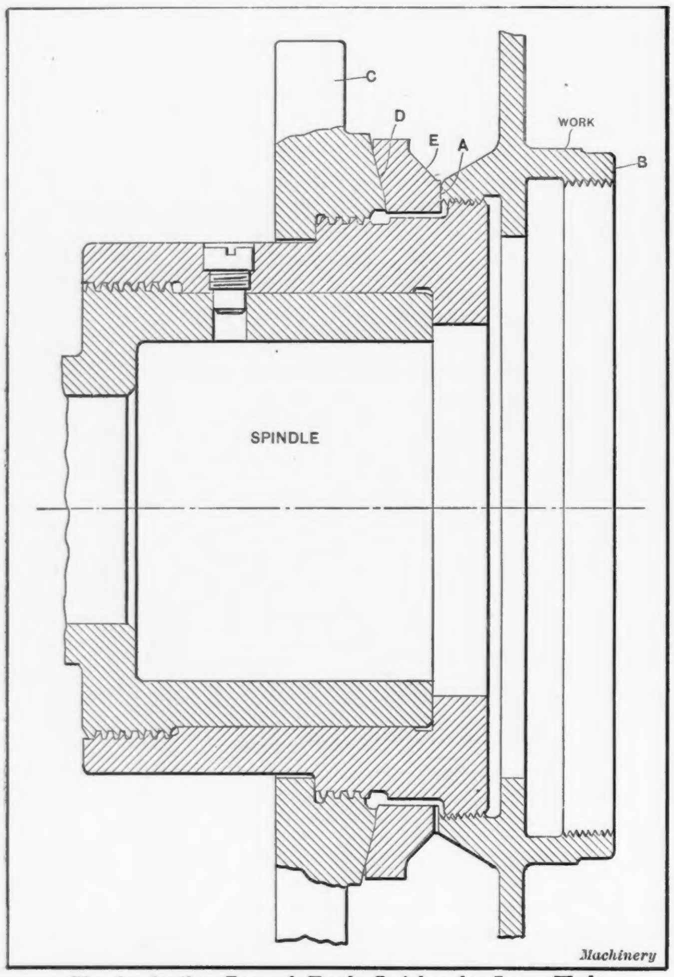

Fig. 9. Another Type of Knock-off Arbor for Large Work

Another large piece of threaded work is shown in Fig. 9, which is considerably harder to handle, in that the ends *A* and *B* are unfinished, and the threads shown must be square and concentric with each other. The construction of the arbor

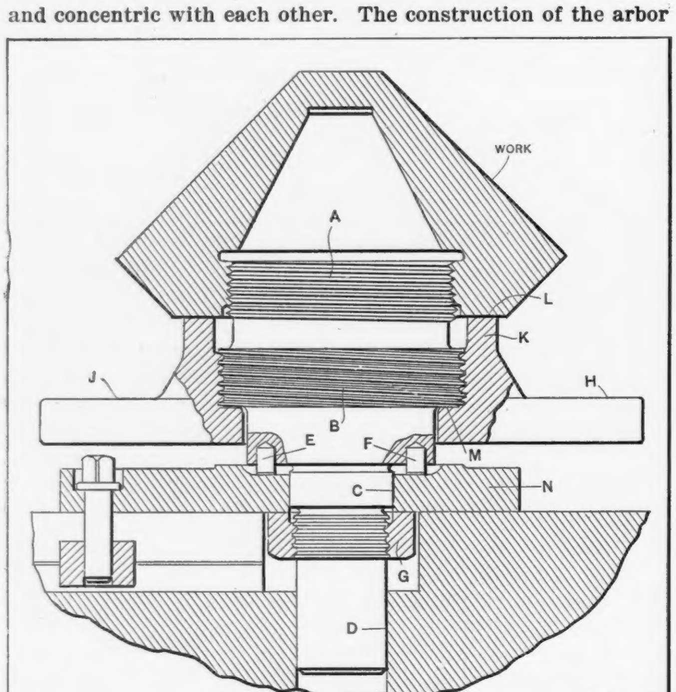

Fig. 10. Knock-off Arbor for Use on Vertical Turret Lathe

for this piece is similar to that shown in Fig. 8, except that the knock-off portion *C* has the forward face formed to a radius *D*, generated on the center-line of the arbor. The cup-shaped washer *E*, has a three-point-bearing against the work at *A*, thereby equalizing the strains and preventing distortion so that the end of the work *B* may be bored and threaded in the correct relation to the other end.

Vertical Knock-off Fixtures for Heavy Work

The application of the arbors previously mentioned has been entirely in a horizontal plane and in the majority of cases, for comparatively small work, but we will take up something of a little heavier nature, and in its application we will construct our fixture in the vertical plane for use in the vertical turret lathe or vertical boring mill.

Fig. 10 illustrates a heavy knock-off fixture which was designed for use on a vertical turret lathe, and the work shown in position on the fixture is a large bevel cone of chrome nickel steel, the conical surfaces of which are required to be in perfect truth with the interior threaded portion. This fixture is called upon to resist the strains incident to very heavy cutting and is necessarily of very rigid construction throughout. The steel arbor is threaded on its upper end at *A*, with an 8-pitch right-hand thread, upon which the work is screwed. Below this, marked *B* in the illustration, is another thread of much coarser pitch, *viz.*, 4-pitch left hand,

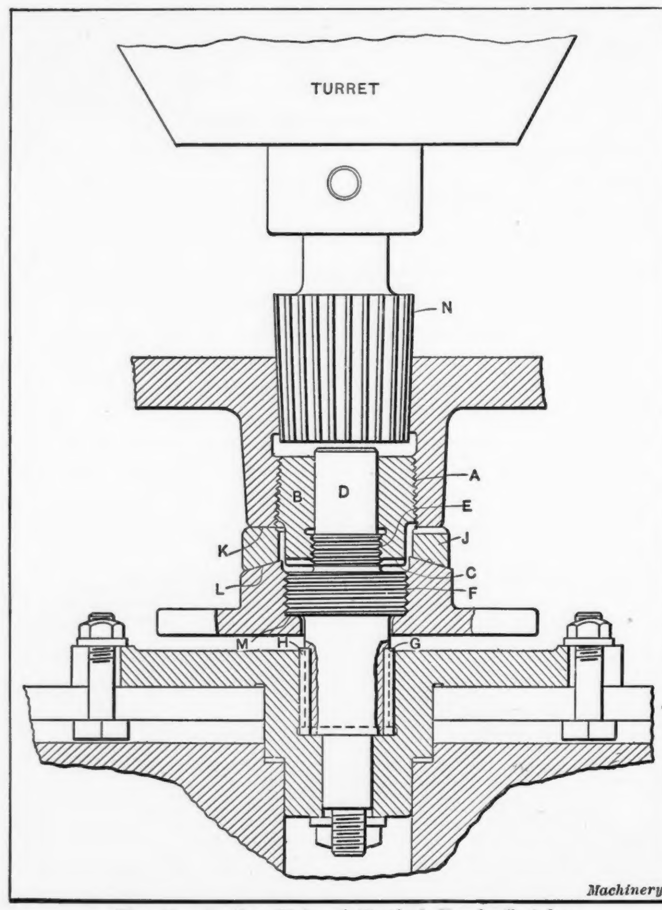

Fig. 11. Another Style of Vertical Knock-off Arbor

and with the Acme type of thread. The cylindrical portion *C* passes down through the body of the fixture, and is ground to fit the hole in the table at *D*, thus acting as a locating plug. The two pins *E* and *F* are obviously used to prevent the arbor from turning, while the nut *G* draws it down against the shoulder. It may be noted that the fixture body *N* is firmly secured to the table by the bolts shown, these being screwed into shoes in the table T-slots. The knock-off portion is a steel forging, having an upper cylindrical section *K* which bears against the work at *L*. A positive vertical stop is assured by the shoulder *M* on the arbor. When using the fixture, the knock-off forging is always brought up against this shoulder before the work is screwed onto the arbor. After the piece has been machined, a sharp blow is given to either of the two lugs *J* or *H*, thus reducing the friction at *L* and permitting the easy removal of the completed cone.

Fixture for a Large Taper Thread

Another vertical fixture which requires in its design, the solution of the most difficult problems in the construction of knock-off arbors and fixtures is illustrated in Fig. 11. The work

is a large steel forging, a detail of which is shown in the lower part of Fig. 1, and it will be noted that the threaded ends are pipe thread taper and must be in line with each other. To make the conditions worse, the end of the hub is unfinished, necessitating careful handling and clamping in order to avoid distortion. In order to understand the situation thoroughly, it may be stated that, in a previous setting of the work, a straight hole has been bored entirely through the piece, and the taper hole on the hub end has been reamed and threaded to the correct pipe thread taper. The taper bushing *B* is threaded on the outside to the pitch of the pipe thread, and it is screwed in place in the work before placing it in position on the fixture. Two slots in the end, shown at *C*, permit the use of a spanner. The interior cylindrical portion is ground to an easy running fit at *D*, and is threaded somewhat loosely on *E*, which is a 6-pitch Acme right-hand thread. The centering and alignment are governed entirely by the upper cylindrical bearing.

The arbor itself has a 4-pitch left-hand Acme thread cut upon it at *F*, and it is driven through the square keys *G* and *H* in the body of the fixture. As the lower end of the work is unfinished, it is necessary to support it in such a way that it will not be distorted, or thrown out of the vertical position. To obtain this result, the collar *J* must be designed to give a three-point-bearing to the piece on the surface *K*. The collar is therefore slightly relieved leaving three high points which bear against the hub, and the cup-shaped bottom allows a rocking action upon the spherical portion of the knock-off at *L*. Except for the spherical surface, this knock-off is about the same as that shown in Fig. 10. Attention is called to the manner in which the positive vertical location of the work is assured, irrespective of the tapered portion, as this is one of the important features of the fixture. It will be readily seen that the clearances between the bushing *B* and the shoulders on the arbor are sufficient to allow for considerable variation in the depth of the tapered hole, and still keep the relation between the surfaces *M* and *K* constant. The taper reamer shown at *N* helps to make clearly apparent the actual working conditions while the fixture is in use.

The majority of the most common conditions have been noted in the illustrations shown in this article, and while more difficult problems may arise occasionally, they may be successfully handled by adaptations of the foregoing.

* * *

VANADIUM STEEL FOR REDUCING MAINTENANCE COSTS

An interesting example of the advantages of vanadium steel in reducing maintenance and production costs has been furnished by one of the largest bolt manufacturing companies in this country. This company has had considerable experience with vanadium steel, having used it for a variety of purposes for over two years. Some of its most troublesome and costly maintenance problems have been solved by the use of vanadium steel for machine parts.

One of the principal applications of vanadium steel in the line of machine repair parts is chrome-vanadium steel crankshafts for bolt heading machines. Prior to the adoption of chrome vanadium steel, 3½ per cent nickel steel has been used for these parts and the nickel steel had in turn replaced the carbon steel shafts with which the machines were originally equipped. The service is severe, the crankshaft being subjected to repeated shocks and vibrations which tend to cause fatigue. In addition to the strains of ordinary service the crankshaft frequently must resist excessive and suddenly applied loads as a result of carelessness of the operators, causing accidents that are practically unavoidable in machines of this type working under usual shop conditions. A material of high dynamic strength or resistance to fatigue is required. The use of nickel-steel shafts failed to satisfactorily overcome the troubles experienced with carbon steel, breakages of the nickel-steel shafts being frequent. The failure of nickel-steel shafts led to the use of chrome-vanadium steel shafts forged by the Erie Forge Co., Erie, Pa. Since the beginning of the use of chrome-vanadium steel two years ago, not one of the shafts has failed. Each shaft is stamped with the name of the material and date of its application to the machine.

MILLING DIE-BLANKS ON AUTOMATIC GEAR CUTTERS

At the Wells Bros. Co.'s plant in Greenfield, Mass., there are two E. J. Flather Mfg. Co.'s gear-cutting machines which are employed for doing work that is so foreign to that usually performed upon gear cutters that they are worthy of description. Fig. 1 shows a general view of the two machines and Fig. 2 shows the details of the work being performed.

Upon the arbor of the machine where the gear blank is usually mounted, a magazine turret has been fitted. The small steel blocks which are to be milled are held in eight slots equidistantly spaced about the turret. These blocks are blanks for threading dies, and nine pieces are held in each slot. These are clamped in position by a cam grip and a cutter of the proper contour placed upon the cutter spindle of the machine. The machine is geared to index to eight positions and the form milling is thus rapidly performed without other attention from the operator than loading the turret. This operation of the machine is not confined to any one piece, for by substituting different holding guides, pieces of different

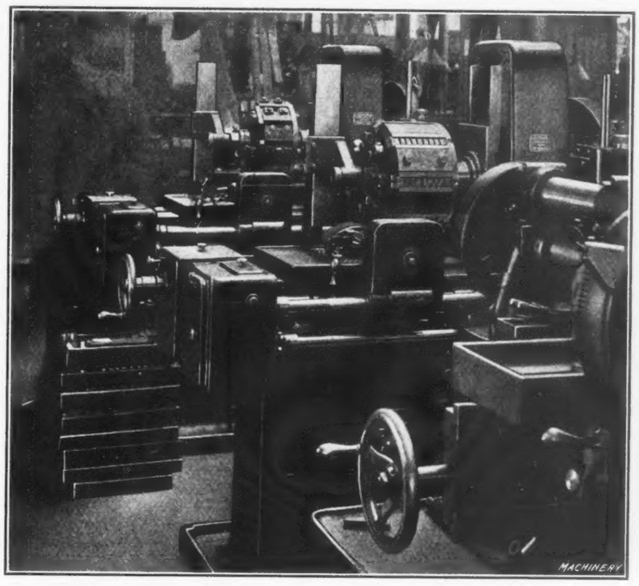

Fig. 1. Automatic Gear-cutters used for milling Die-blanks

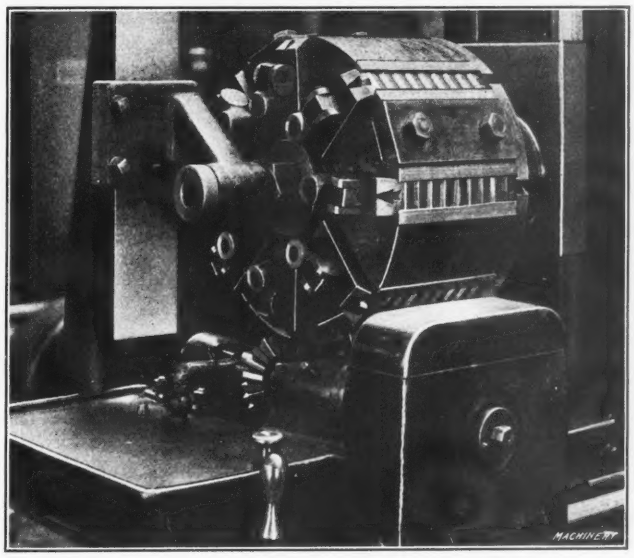

Fig. 2. Close-range View of the Work and Fixture

dimensions may be held and, of course, cutters of any shape may be used upon the cutter spindle. In this way there are many jobs which can be handled by these machines.

On the job shown, which involves the milling of tool steel blocks 2 inches by 1¼-inch by ⅞-inch thick, the production is at the rate of 450 pieces per day from each machine. One man has no difficulty in taking care of two machines and, if the work demanded, could undoubtedly look after four of them if on similar work. C. L. L.

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THE BENEFITS OF STEADY PRODUCTION

Irregularity of demand for American manufactured products has created conditions inimical to general prosperity. The tendency of late years is to manufacture to order only, thereby avoiding the tying up of capital in stock. While this practice enables a manufacturer to concentrate a large percentage of his capital in the means of production, it has the great disadvantage of producing irregular demands for product and a consequent unsettled labor market. At one period in the year, the demand for goods may be so heavy that shops, mills and factories are unable to supply it even though working to full capacity and running over time. Under such conditions, labor is at a premium and men are hard to get at any price. In six months, the conditions may have so changed that the plants are running with reduced force, and men are thrown out of employment and leave town to seek work elsewhere.

Aside from the moral side of the question, this is bad business. An efficient corps of workmen is formed only at considerable cost. To ruthlessly break it up is to lose money for the concern. The workman's loss is obvious, but the money loss to the employer is concealed by the apparent saving due to reduction of the pay-roll.

The ideal plan of running a manufacturing plant where men are working an eight-hour day is to run three shifts twenty-four hours a day. Obviously, with efficient superintendence the yearly capacity of a plant run on this plan is three times that of one running on one shift only. The capital invested in machinery and buildings yields three times the return on three daily shifts that it does on one. The bad social effects of the three-shift plan as well as the difficulty of obtaining and maintaining competent foremen probably will always prevent this plan of operation being generally adopted. It is one, however, that offers relief to the manufacturer who would maintain a permanent organization and at the same time have working capital available to invest in stock during dull periods. With comparatively little capital invested in machinery earning three times that of the equipment of the common concern of the same capacity, more capital can be safely tied up in stock, thus steadying the labor market and providing goods to fill orders immediately.

If more goods were made during dull times to supply orders in brisk times, these periods of abnormal demand would decrease in intensity. The benefits that would follow are too evident to require argument.

THE RECORDING OF ENGINEERING DATA

Many engineers of exceptional ability in carrying on experimental work and in determining data of importance in engineering, lack the ability to place these data on record in such a way as to make them easily available for general reference. To be able to take a mass of miscellaneous data, and put them in such shape that others may be able to use the data without wasting a great deal of time in "digging it out," is a valuable asset for an engineer. Reports are often presented by committees before engineering societies in which the essentials are so hidden among a mass of words that it is impossible to quickly grasp the subject. Tabulations are often made in a form from which it is difficult to obtain the essential information. Committees that are to present reports containing a great deal of engineering data should endeavor to have their data put in satisfactory shape by someone who is capable of properly arranging it in the most comprehensive and simple manner. The value of papers presented before engineering societies would also be greatly enhanced if the information contained were carefully condensed and the data given, properly tabulated. The best handbooks, as well as the engineering journals, indicate the method that should be used, although many handbooks are at fault even in this respect. Sometimes it is very difficult to find the essentials among the mass of information presented. Engineers in general should give more study to this subject and take more pains to present such data as they give to the engineering world in the manner best suited to meet average needs.

* * *

MACHINE FORGING

The making of forgings by machine methods is an art about which very little has been published, although remarkable advances have been made in this direction in the last decade. The upsetting and forging machine produces forgings by a process which might be called "machine blacksmithing," as it performs the same class of work that formerly was accomplished only by hand forging. Machine forging has many advantages over the well-known hand method of producing machine and engine parts, and supercedes the old method in many progressive shops. The difference in the cost of manufacturing parts by the two methods is in many cases almost unbelievable. For instance, a certain engine part which by ordinary blacksmithing methods cost $7 to produce was handled successfully on the upsetting and forging machine at the rate of 30 cents a piece.

It is possible to produce a much greater range of work in an upsetting and forging machine than by drop forging, and one chief reason for this is the method of handling. For instance, in forging with a steam or drop hammer, only two dies, a lower and upper one, are used. The gripping dies in the forging machine perform practically the same function, but in addition to these, the forging machine is also provided with end-working plungers which greatly increase its manufacturing possibilities. Another advantage of the forging machine is the feasibility of carrying a part through the various stages of manufacture without removing it from the machine to the heating furnace. This is made possible by having a series of impressions, ranging from one to four, cut in the opposing faces of the gripping dies and a corresponding number of plungers operated by the ram of the machine. With this combination, it is practicable to turn out parts which could not be produced by any other method in anywhere near the same time.

Another feature of the forging machine which is worthy of attention is its use for the welding of parts. Welding operations can be performed just as successfully in a forging machine as by hand, and of course the former method is much more rapid. Wrought iron welds more readily in the forging machine than steel containing a high carbon content, but when handled properly, steel parts can be welded successfully, a flux being generally used for this operation. The possibility of doing general welding in the forging machine opens up a wide field, as scrap metal can be utilized in the production of expensive machine and engine parts, thus reclaiming material otherwise almost worthless. When the use of the forging machine becomes better understood, it should prove a very important factor in manufacturing.

GEAR CASINGS AND GUARDS

A generally accepted principle of machine design is that a casing concealing and protecting mechanism should conform to the shape of the mechanism. It is a rule that should be tempered with discretion, however, when its rigid observance requires casings of ungainly shape or very irregular form. In those cases the effort should be to produce a pleasing outline, even though comparatively large unfilled spaces are a result. The casing will cost less for pattern making and molding and will usually be of more convenient shape for machining.

Another point that is sometimes ignored in designing gear casings for machine tools is to provide for making the casing so that it can be readily removed without disturbing other parts. A motor should not be mounted on top of a headstock in such a manner that if the casing has to be lifted the motor must first be taken off. The principle of easy accessibility is violated by any design requiring the dismantling of one important member in order to reach another.

* * *

MEN MORE IMPORTANT THAN METHODS

When the organization of many successful manufacturing concerns is carefully analyzed, the most impressive fact is that men composing the organization are more important factors in its success than the methods employed. What we mean is that while the methods used must be good to be successful, they are not necessarily the only ones that the same men could employ with success. The same methods, used by another organization of men unfamiliar with the conditions under which they were developed and not working in harmony, might easily fail.

Many concerns which have developed successful manufacturing methods are naturally conservative about disclosing them to competitors. They argue that as the knowledge acquired cost them considerable time and labor to develop, it would be giving away an advantage to furnish a competitor with that knowledge free of cost. While this view is quite human, the actual result of publishing information about improved methods works out differently. Mere knowledge of improved machines and methods is of little value to competitors if they have not the men to put them into use. Certain elements of knowledge can only be acquired by actual experience. To tell a man how to perform an operation and for him to actually do it are quite different. Team work is essential for success, and every concern must develop it in its own works.

* * *

THE DEVELOPMENT OF BROACHING

The cutting of keyways and machining of holes in metal to shapes other than round by broaching is an old practice, but one that has attracted comparatively little attention until within the past ten years. While machines were built and used for broaching they were not in common use until about 1900, when the automobile business developed rapidly.

Now the broaching process is used very extensively, not only by automobile manufacturers but by many other concerns. Such parts as vise jaws are advantageously shaped for the rectangular bar by broaching, and while this is relatively large work, the trend of practice indicates that much larger and heavier parts will be machined in this manner when the quantity of work warrants the necessary investment in machines and tools. The keyways of "paracentric" locks are broached; the peculiarity of this operation lying in the irregularity of the slot which forbids the use of practically every other machine operation. On the other hand the broaching machine is becoming a recognized means of cutting external shapes that are readily machined with standard tools. The reason for this is the high rate of production and low cost.

The advantages of the broaching process are speed, interchangeability of work, adaptability to irregular forms, employment of comparatively unskilled labor, and adaptability to a great variety of work. The chief disadvantage is the high cost of broaches and the uncertainty of their life. One broach may cut 20,000 holes while another made of the same steel and tempered in the same manner may fail before 2000 are cut. While chiefly applied now to interior work, exterior work is also being successfully done, and one of the possibilities is broaching spur gears when the quantity of duplicate gears is large.

CHARACTERISTICS OF FRICTION CLUTCHES

BY J. W. BRASSINGTON*

It is not the intention of the writer to discuss the relative merits of any of the different types of friction clutches now on the market, nor is this article written as an exposition of the theory of the friction clutch. The intention is to attract attention to the importance of the friction clutch as a part of many types of machines, and also to call attention to the lack of adequate technical information covering the principles that must underlie the design of a successful friction clutch. Take any friction clutch catalogue, as at present issued by a manufacturer of clutches, and on turning the pages you will probably find a table giving what purports to be the horsepower capacity of the various sized clutches, for a given number of revolutions per minute. Such a table will probably show that the manufacturer believes the horsepower capacity of each clutch varies directly with the number of revolutions per minute. In no case, within the writer's knowledge, is any information given covering the "pick-up" capacity of a clutch at any given speed, nor has he yet come across a trade catalogue giving the starting torque of any clutch.

The wonderful development of the automobile that has taken place in the last few years has thrown a great deal of light upon the qualities that are essential for a successful clutch. It is somewhat of a shock to the mill or shop man to realize that some of the automobile manufacturers equip their machines with clutches that, in spite of the exceptionally severe service they are subjected to, actually outlast the automobile, of which they are a part, without requiring any special attention or repairs. The purchaser of an automobile is an unreasonable fellow and he would not, as a rule, submit to the infliction of a clutch that would make him conscious of its existence by giving any trouble whatsoever. Will any mill or shop man, using a friction clutch to start up and run heavy machinery, expect to buy a clutch at a reasonable price that will not require a new disk, collar, brake band or such like repair, at fairly frequent intervals? Part of the trouble is caused by the fact that the buyer of the clutch, even if he takes one big enough to transmit the power wanted at the running speed of the machine in question, does not make sure that it has capacity enough to start up from rest when the machine is heavily loaded. Again, it is probably rarely realized by the buyer that the "pick-up" capacity of a clutch is inversely proportional to the speed, while its transmitting power is directly proportional to the speed.

As this is a subject full of interest from both a practical and theoretical point of view, the writer wishes to place before the readers of MACHINERY the following statements, for the truth of which he can find no confirmation in present trade catalogues, but he feels it is probable that some reader's experience with friction clutches may endorse his belief in their accuracy:

1. The starting torque of the common friction clutch is a constant up to a certain speed of the driving shaft, and beyond this point, it rapidly drops. 2. The "pick-up" capacity of a clutch varies inversely with the speed. 3. The work done by a clutch in "picking up" a load is directly proportional to the moment required to turn the mechanism to which it is attached, *i. e.*, the work done by a clutch in "picking up" a load is directly proportional to the weight of the load. 4. The work done by a clutch in "picking up" a load, is directly proportional to the square of the velocity of the mechanism to which it is attached. That is to say, if we double the speed of the driving shaft and then throw in our clutch on the same load, the work the clutch will have to do to start up the same machine from rest to double the normal speed will be four times as great as the work required of the clutch to start the same machine at the normal speed.

We may state this algebraically as follows:

$$F = \frac{1}{2} \times \frac{W}{g} \times V^2$$

where

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F = the amount of work done;

W = the weight moved;

V = velocity of moving parts in feet per second.

This is the well known equation expressing the work of acceleration.

Now let us refer to the work of the builders of automobiles, and find out something about their clutches. It seems to the writer that the most successful clutches in the automobile trade are those that are made to slip as well as to grip. The heavy steel 'busses in the streets of Paris are run in such a manner that their speed is controlled by the clutch; *i. e.*, at the slower speeds of the 'busses the clutch is allowed to slip. This is probably a new way of looking at a clutch to many of us, and it is wonderful how much good it does a man to look at anything from a different point of view. It is evident that a clutch that cannot be thrown in too quickly, and that will slip as it gradually picks up the load, is spared the destructive treatment that must be the lot of a clutch that is thrown in too quickly and made to destroy itself starting up a heavy load from rest to a high speed. For instance, suppose a clutch is used to start up a load of ten thousand pounds from rest to an average speed of one foot per second, then the work required to pick-up is found from the preceding equation to be:

$$F = \frac{10,000}{64} \times 1^2 = 156 \text{ foot lbs.}$$

Now let us speed up the machine to say three feet per second and throw our clutches in. The "pick-up" power required for the same machine is expressed thus:

$$F = \frac{10,000 \times 3^2}{64} = 1410 \text{ foot lbs.}$$

This means that a clutch nine times as large is required to "pick-up" the load in the same period of time. Yet our friend, the clutch manufacturer, would probably offer a smaller clutch in the second instance than in the first because the speed or revolutions per minute is three times as large and, as per his catalogue, only requires a clutch of about one-third the size. From some data jotted down at intervals during a busy life, in a note-book that is a kind of catch-all of miscellaneous information, the writer finds that quite a number of the friction clutches now on the market have been given a rated horsepower by multiplying the number of square inches of frictional contact, by the mean radius, by the number of revolutions, by some constant, and dividing the present by 33,000. The constant is generally about 10, and it represents the number of pounds of pressure per inch of frictional contact. This figure multiplied by the coefficient of friction for the material used, and then by the number of square inches of frictional contact, gives approximately the power required from the leverage and motive power provided to throw in the clutch.

The writer does not profess to be an expert on the clutch question, although it has caused him some thought and some trouble in the past. All of the trouble could not always be traced to the want of judgment on the part of the clutch operator or purchaser in giving a clutch too much work to do. The average clutch manufacturer is not as yet sufficiently imbued with the spirit of the times to make public the engineering information covering this subject, either in his catalogue, or by the ready and courteous tongues of his salesmen.

* * *

MICARTA—A SUBSTITUTE FOR FIBER, RAWHIDE, HARD RUBBER, ETC.

A remarkable new material to take the place of hard fiber, glass, porcelain, hard rubber, built-up mica, pressboard, rawhide, molded compounds, etc., has been developed by the Westinghouse Electric and Mfg. Co., East Pittsburg, Pa. The material, which is known as "Micarta," is used for commutator bushings and brush-holder insulation, as noiseless gear blanks, as conduit for automobile wiring, as spools for spark coil and magnet windings, for refillable fuse tubes, for wireless coil separators, for arc shields in circuit-breakers, for water meter disks, etc.

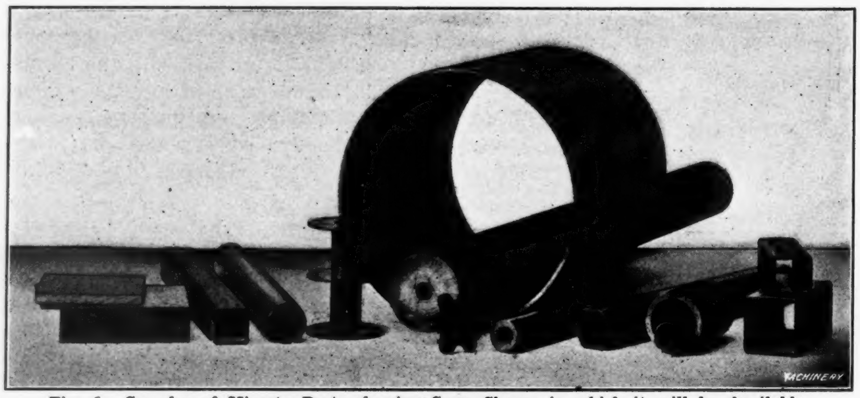


Fig. 1. Samples of Micarta Parts showing Some Shapes in which it will be Available

Micarta is a nard, tan colored, homogeneous material having a mechanical strength about fifty per cent. greater than hard fiber. It can readily be sawed, milled, turned, tapped, threaded, etc., if a sharp pointed tool is used and the work done on a lathe. It can be punched only in thin sheets and cannot be moulded. Micarta is not brittle and will not warp, expand, or shrink with age or exposure to the weather but takes a high polish, presenting a finished appearance.

Two grades of the material are made. The grade known as bakelite micarta will stand a temperature of 150 degrees C. (300 degrees F.) continuously, or 260 degrees C. (500 degrees F.) for a short time. It is infusible and will remain unaffected by heat until a temperature sufficient to carbonize it is reached. Heat will not warp bakelite micarta, and it will stand an electric arc better than hard fiber, hard rubber, built-up mica, or any moulded insulation containing fibrous or resinous materials. Its coefficient or expansion is low, being approximately 0.00002 inch per degree C. Bakelite micarta is insoluble in practically all of the ordinary solvents such as alcohol, benzine, turpentine, and weak solutions of acids, and alkalis, hot water and oils. It is indifferent to ozone—an advantage over hard rubber, resins, etc., for electrical purposes. It is non-hydroscopic and impervious to moisture.

The other grade designated as No. 53 micarta has the same mechanical and electrical properties as the bakelite micarta but differs in its chemical and thermal properties. The plain micarta behaves toward chemicals and heat very much as an ordinary resin. This grade is not used in plate form.

Fig. 2. Tube of Bakelite Micarta fractured by Endwise Compression to show Remarkable Homogeneity

As proof of the uniformity of structure of bakelite micarta, an illustration of a fracture is shown in Fig. 2. This is not a saw cut, but a natural break. The tube was held tight on a metal mandrel and a compressive force was applied at one end of the tube. When the force became sufficiently great the tube split as shown. The uniformity of the wavy fracture shows how homogeneous the material is. Such a break is known as a "harmonic fracture." The strains in a homogeneous material under stress follow a sine wave law. If one part of the material is weaker than the rest, the strain at this point becomes greater and the harmonic wave is distorted. However, it will be seen from the illustration, made from an actual photograph, that the strain followed the true harmonic wave almost as closely as the eye can detect, indicating that every part of the material was exactly as strong as every other part.

SHOP CRANES—THEIR DESIGN AND CONSTRUCTION*†

HORSEPOWER OF MOTORS—GEARING—BRAKES—GIRDERS—END CARRIAGES—PLATFORMS, ETC.

As in all other mechanisms, the principal point to consider in connection with modern shop cranes is economic design for the greatest efficiency—in other words, the minimum of material in the right place for the greatest utility. We will first of all consider a jib crane, which is the most universal design of fixed crane. Among the various types employed for different services in shops, the simple under-braced type is the most common. In designing, we must first know all the loads that the crane will be subjected to, both moving and fixed, and then proceed to lay out the diagrams showing all the stresses to which this particular crane will be subjected. A typical crane used in shops over machines, and fixed against a wall or on a column in foundries, consists of a mast or pillar resting on a foundation and supported at the top. The jib secured to the mast or pillar is supported by a strut which is fixed to the pillar. First, we must know the load which is put on the crane. The overhang or cantilever is usually made about a quarter of the distance between the column and where the strut is connected to the jib. When the load is at the center or at the end of the cantilever the bending moment is practically the same. This ratio should be proportioned to produce the same stress in both cantilever and span. The next step is to obtain the reaction at the junction of the strut and the jib, and the jib and the column. We then draw the parallelogram of forces to scale, and measure the lines to obtain the forces for the required sections.

Overhead Traveling Cranes

The overhead traveling crane in its various forms is probably in greater demand than any other type of crane on the market. Electrically-driven overhead cranes are most universally used for heavy loads, especially when continuous running and rapidity are required. The three-motor crane is the most efficient for modern workshop practice, but until recently, the single-motor crane was considered the cheapest for engine houses and places where only an occasional lift was required. The present price of motors and the fact that single motors require more gearing are two reasons for prefering three-motor cranes. One of the principal obstacles which make standardization difficult is the various opinions as to speeds. There is no reason why this type of crane should not be worked at the same speeds by the various manufacturers, as most makers who state the speed of their standard patterns are very nearly in agreement.

In selecting the speed at which the load is to be lifted, it should not be overlooked that the nominal load is seldom more than 20 per cent of the full capacity of the crane. It is better, therefore, to consider the highest safe speed at which this load can be worked, and then select a full load speed which will give the same foot-tonnage of work done. By the use of series-wound motors, a variation up to 50 per cent above the rated speed can be obtained, so that it is unnecessary to use change gears on the main lift. On cranes, say over 20 or 25 tons, where the full load is only occasionally handled, and the crane is used frequently for light loads, it is often economical to have an auxiliary barrel fitted on the crane and worked by a separate motor with a capacity of 5 to 6 tons, and a speed of 20 to 40 feet per minute, the lift being 1/5 the full capacity of the crane and the speed such as will give the same foot-tonnage as the main lift. It is never worth while to have a change of gear to the cross traversing and traveling motors. The speeds are variable according to the work required to be done.

Obtaining the Horsepower of the Motors

The power required of the lifting motor depends purely on the work done on the load and the power absorbed in the friction of gearing, journals, etc. It varies with the number of reductions and the type of gearing. A common rule in practice is to allow 10 foot-tons of work done at the hook per B. H. P., this being equivalent to a mechanical efficiency of about 66 per cent. The power required for cross traversing and traveling must be sufficient to overcome the rolling and axle friction and the friction of the intermediate driving gears. For practical purposes, resistances of 40 to 50 pounds per ton for cross traversing and 60 to 70 pounds per ton for traveling are allowed for the best class of traveling cranes which have large diameter wheels and machine cut gears.

Framing and General Details of the Crabs

The difference in appearance of cranes is chiefly in the design of the crabs themselves. There has been a difference of opinion as to the materials adopted, some makers using cast-iron frames up to considerable sizes, but it is now almost universal practice to use a steel framing for all sizes. The chief idea in designing is to make all parts as accessible as possible in order to facilitate removals, repairs, and general attention; and to keep the structure as light as possible, and still maintain the required stability. Some makers use either double or single steel plates, but these box up the motors and gearing too much, and, what is worse, necessitate solid bearings.

The running wheels and axles are the first members to be considered and the material from which they are made is important. For first-class work, cast iron should not be used above 10 tons, as there is considerable weight that the wheels and axles are required to carry, and they will soon show signs of wear. Cast steel should be used for this purpose. The wheels should be made as large as possible, in order to reduce the tractive resistance. The axles should be made as small as possible, but care must be given to their design, as they are subject to combined bending and twisting; in the first place due to overhang, and secondly due to resistance of traction. The overhang from the center of the bearing to the center of the wheel should not exceed 5 inches, and the working strain should not exceed 5.5 tons per square inch. The length of the bearings should be designed to give a pressure of not more than 900 pounds per square inch of projected area. They are usually made of cast iron with brass bearings on the top. The most important part is the lubrication, and for crabs of over 40 tons, the use of self-oiling bearings should be adopted. Roller bearings are also sometimes adopted for this purpose on heavy cranes. For very heavy crabs, the axle bearings are sometimes put on both sides, which enables less width in bearings to be used and the gearing can be more compactly arranged. One wheel on each side would require to be geared with this arrangement.

Rope Details

The barrels are usually made of cast iron, with the rope grooves turned in to suit the diameter of rope to be used. Particulars of steel ropes suitable for this work are given below, and can be taken approximately:

Loads in Tons	No. of Ropes	Circumference in Inches
3	2	1¾
5	2	2¼
7.5	4	4
10	4	2¼
15	4	2¾
20	4	3¼
25	4	3½
30	4	4
40	4	4½

The usual factor of safety is 8, which allows a good reserve strength if a few strands break. The life of a rope depends largely on the diameter of the barrel and the number of pulleys it passes round. Some makers recommend a barrel diameter 6½ times the circumference of the rope; this appears suitable for ropes under 3½ inches circumference, but above this size, 5½ to 6 times the rope circumference should be quite large enough for the barrel diameter. An important

* Abstract of a paper read by Frank W. Suffield before the Birmingham Association of Mechanical Engineers, Birmingham, England.
† For further information on this subject see "The Design of Jib Cranes" in the October, 1908, issue of MACHINERY; "Design and Construction of the Electric Overhead Cranes" in the January, 1909, issue of MACHINERY, and other articles there referred to. See also MACHINERY's Reference Books Nos. 47 and 49.

point is the spacing of the ropes on the barrel—that is, the distance between the centers of the grooves. For all ropes up to 4 inches in circumference, ⅛-inch should be left between the sides of the ropes, but above that size, 3/16-inch should be left if possible. This is to allow for the flattening of the ropes while under load, and to avoid their grinding together. The usual practice is to allow the lift to be taken in the center of the barrel to distribute the load more evenly on the girders. From 7 to 50 tons, the load should be lifted on four parts of the rope—that is, two parts in right and left hand grooves on the barrel, the other end passing around a pulley. This pulley need not exceed twice the circumference of the rope.

For cranes up to 3 tons, the load should be lifted in a single pull of rope; 5, 6 and 7 tons with two, one coil being on the barrel; four ropes up to 50 tons, six ropes up to 75 tons, and so on. It is not so important to lift centrally with small cranes, as the load on the girders can never exceed their strength. The thickness of metal in the barrel must be considered, and the stress of bending kept within safe limits. The barrel shaft must be considered in the same way as other shafts, also the bearings with the same bearing pressure.

Gearing

Gearing is one of the most important parts of the crane design, whatever kind of crane is being considered, as the efficiency and safety of operation depend upon it. Although machine cut gears increase the cost of the equipment, the saving of current used by the electric motors will enable the cut gears to soon pay for themselves. For heavy loads it is advisable to use cast iron for the barrel gear and pinion. It is also advisable to shroud the pinion and as the speed is low, the loss due to friction is not worth considering. Rawhide motor pinions in mesh with cast-iron gears are found to be suitable for the first reduction on cranes up to 20 tons. They run very smoothly and do not require lubricating. Above 20 tons, the motor pinions ought to be machined steel running with cast-iron or steel wheels in an oil bath. It is usual to make the steel pinions from a solid steel bar or forged piece; the pinion teeth are stronger than those of the wheels. If cut from cast iron, they are of about the same strength as cast steel wheels. The barrel wheel and pinion for cranes up to 20 tons are made of cast iron, but above this size cast steel is better, and for all cranes above 7 tons the pinions should be shrouded. For cranes above 20 tons it is good practice to make all of the pinions of steel. Altogether the sizes of the pinions should be as small as possible; and no pinion should have less than twelve teeth.

In crane work, as in all other gearing, the strength of the teeth is most important, and the stress to which they are subjected varies widely in actual practice. The average ultimate strength of cast iron and cast steel subject to bending (as in a tooth) is 18 and 30 tons, respectively. Owing to the nature of the metals and the methods of manufacture, one would be justified in allowing a factor of safety of 8 for cast iron and 6 for cast steel for slow running. Reliable formulas, such as Professor Unwin's, will be found quite satisfactory in use. Involute teeth with radial flanks, which give a short tooth with a broad root, are most often used because of their great strength. The chief value of shrouding is to minimize the tendency of the teeth to break across the corners, especially in the case of cast-iron gears. Double helical gears are sometimes use for the barrel gear and pinion of cranes over 30 tons. Their relative strength, as compared with spur gears, is a debatable question, but as the points of contact are always distributed over the whole of the working face, from root to point, the leverage of the load is only half that in an ordinary spur gear. In practice it is very difficult to make the apices of these gears run in the same plane, any error in this respect causing the load to be concentrated on one side of the wheels, so that care must be taken in working out the strengths not to allow too much for the advantage that double helical-shaped teeth have over the ordinary type, although they are about 1 to 1½ times stronger. The question of design and strength of the arms, rims and hubs must be gone into carefully, for it is these details that give good results, both in the cost of manufacture and in the service obtained by the purchaser.

Brakes

Electric-driven cranes must be fitted with effective brakes, and of these there are two kinds—magnetic and mechanical. The magnetic brake is generally of the strap or clamp type, and is held off by a magnet or solenoid connected with the motor, so that when the curren is taken off, the brake comes into action. To avoid a too rapid action of the brake, the solenoid is equipped with a dash pot, the air being throttled in a small hole at the top of the body. The magnetic brake must be sufficiently strong to hold the full load in event of the mechanical brake failing. When both brakes are in use the solenoid is almost solely used for stopping the motor quickly, and as it will run both ways the clamp type of brake is found most suitable. Brake pulleys on the motors should be as large as possible, yet the peripheral speed should not exceed 2000 to 2500 feet per minute.

Girders

The consideration of the main girders, and the selection of the most suitable type for a given crane is an important point, since the general efficiency of the crane is affected by the girders, which represent the bulk of the weight. Furthermore, if the contract is to be awarded to the lowest bidder, economy has to be taken into consideration and the design worked out to make use of the lightest sections that will give a safe stress. For this purpose, a stress of 5 to 5½ tons per square inch should be the limit, and this will cover all contingencies and avoid undue deflection in the shafts, etc. There are four principal types of girders in use: (1) rolled steel joists; (2) box plate girders; (3) single web plate girder; (4) braced or lattice girders.

1. The rolled steel joist is, of course, the simplest type of girder and is frequently used for spans up to 40 feet for light loads, and in spans up to 30 feet for loads as high as 20 tons.

2. For cranes above 15 tons, in spans up to 65 feet, box girders are considered excellent, but they are at a great disadvantage, on account of the fact that they cannot be got at for painting inside.

3. For cranes up to 15 tons, say, up to 40-foot span, where rolled steel joists are not stiff enough, the single web plate girder can be used economically with one or two provisions, such as that the speed must not be excessive. Platform girders should be added and braced horizontally to the main girder.

4. For cranes up to and including 4 tons, above 40 feet, and for all 65- or 75-foot spans, braced girders of all descriptions are the most economical. From the points of cost, weight and convenience the Warren type has been found to be the best. Where the rolling load is large and heavy in proportion to the structural load, the double or partly double lattice girder is adopted.

The first step of calculation for crane girders is to obtain the bending moment in the ordinary way. This must include the forces due to (1) rolling load; (2) weight of crabs; (3) structural load—that is, the weight of girder, platform and cross shaft—if the driving motor is in the center this must be added. We do not propose to consider impact forces in any one case, as these are often neglected by crane builders, although, in our opinion, something should be added, especially for high-speed cranes. If the crab is symmetrically built, the rolling load may be considered as being divided equally on the four wheels; consequently it shortens the effective span of the girder by the distance between the centers of these wheels. This bending moment of the rolling load is obtained by multiplying the reaction at either support by the distance from that support to the center of the crab wheel nearest the support. The bending moment due to the structural load is found in the usual way.

The next question is the depth of the girders, and this will vary according to the size of the crane. For heavy loads it is more economical to increase the depth than to make the flanges heavy. We must first assume a suitable section, now that we can decide the depth, allowance being made for rivets. The web-plates should not be less than ¼ inch thick under any circumstances, to allow for deterioration, and for box girders this thickness can be used up to 20 tons; 5/16 inch for 30 to 50 tons, and ⅜-inch above these loads. For single web girders, ¼-inch plates can be used for cranes up to 7 tons,

5/16-inch to 20 tons, and ⅜-inch for heavier loads. These sizes are only approximate, and in some cases stiffeners, which are usually made of T-irons, will be required, but they do not need to be at such close centers as for bridge work. Stiffeners at intervals of 4 feet to 5 feet is all that is necessary in most cases, but it depends entirely on the size of the girder and the loading. It is quite unnecessary to have the full length of the girder the same depth, and it is usually made "fish-bellied."

For high-speed cranes we must consider the lateral stresses due to suddenly stopping the load. To this must be added the distributed effort, as well, which will equal about 0.95 of the stress due to momentum. We must, therefore, see that the total lateral stress does not exceed 4 tons per square inch under these conditions, so as to avoid any possibility of distortion from the concentrated load. It is obvious that the girders might fail in this way and yet be amply strong to carry the load in the span, but the fixing of the platforms often assists very materially in overcoming the difficulty.

The details of the Warren and lattice types of girders vary somewhat with the size of crane, but the stresses to be considered first are found by the same method for all conditions. This kind of framed structure is composed of a compression and a tension flange, kept in position by diagonal members, which are subject to compression and tension alternately as the load moves along. In order to minimize the extra load to which the top flange is subjected on account of the crab wheels, a vertical member is inserted to reduce the spans between the diagonals. These girders can be made parallel or fish-bellied, according to the judgment of the designer. The stresses may be obtained either by moments or diagram. For this purpose the writer's practice is to first use the graphical method and then check the results obtained in this way by the method of moments. It is economical design to use as few sections as possible, taking the section that is required to carry the maximum stress and using the same section throughout the length. A sufficient number of rivets should be allowed for at the joints to limit the stress to 5 tons per square inch in shear, and 8¾ tons per square inch of bearing.

End Carriages

In order to calculate the strength of the end carriages we must know the load of the crab at the extreme end, to which must be added the weight of the girders themselves. It is also necessary to fix the center of the girders and the traveling wheels. The first depends upon the requirements of the crabs, and the second should be about one-fifth of the span. Channels are most convenient, or plates and angles. The wheels should be from 18 inches to 30 inches in diameter, according to the size of the crane, and made of cast steel or cast iron with steel treads. The toothed wheel should, by preference, be bolted to the wheel, rather than keyed separately or cast in one piece. One of the greatest objections to the cheap crane is allowing these wheels to be bushed and run loose on the spindles, and this is one of the many bad features which are adopted to cheapen the cost of a marketable crane; and, further, it is seldom noticed by buyers, who do not trouble to look into details or get anyone who may know to assist them.

Platforms

The platforms may add to or detract from the appearance of a crane, and it is very largely a matter of opinion as to whether there shall be one, two or none at all. For light lattice or single web girders it is found cheapest to use light subsidiary girders and fix them to the main girders with diagonal bracing. In some cases of this kind, the top plate of the girder can be extended to form the platform, which practically strengthens the construction. When the crane girders are stiff enough, brackets can be attached to the sides of them, but these must be designed to be uniform with the remainder of the work. Timber is usually used for this purpose on account of its cheapness and lightness. The cab is made of a very light construction, and suspended from the end of the main girders. It should be just large enough to contain the controller, switches, and provide room for the driver to sit down. Lubrication is a very important point, and every facility must be made for fixing lubricators when oil baths are not used.

As to progress through the works, the material is usually ordered from the mills in lengths and sizes suitable for the particular order, as far as the plates are concerned, and the bar material in lengths of 30 feet or 40 feet. The detail drawings are taken into the templet shop and all the templets are made, and from these the required material is marked off for drilling, punching, trimming and cutting to lengths. After the machining has been done, all the pieces of one girder which are to be riveted are assembled, and these are bolted in their respective positions ready for the riveter. When the riveting has been done, the parts are ready for oiling or painting.

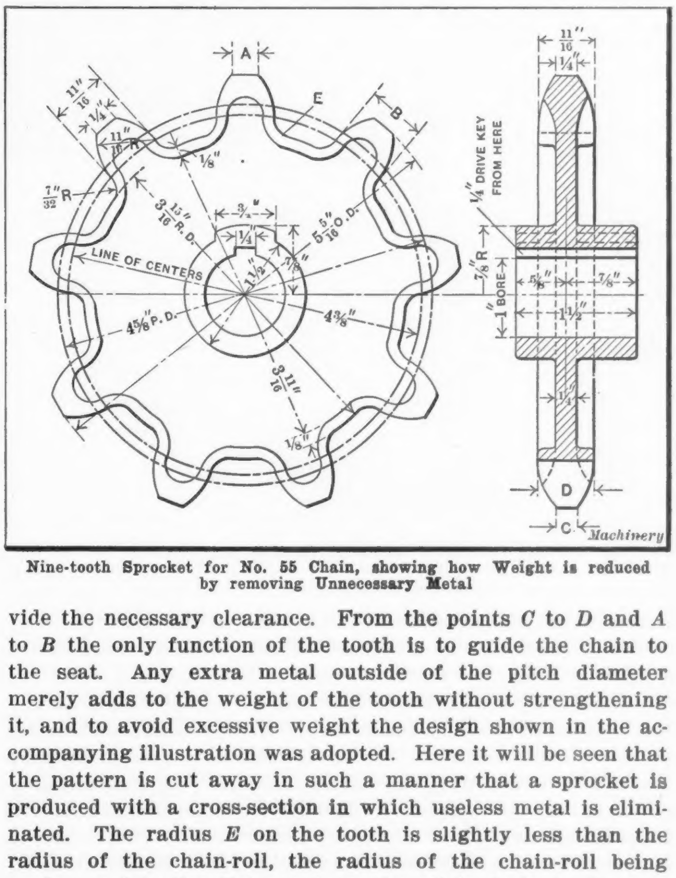
* * *

STANDARD SPROCKETS FOR DETACHABLE LINK BELTS*

BY J. R. BOWEN†

The Data Sheet supplement accompanying the current number of MACHINERY was developed by the writer to take the place of an old shop method of figuring chain drives, the object being to expedite work in the drafting-room and to develop a uniform system of sprockets. The writer has had experience both as a draftsman and patternmaker and has developed the present standard to meet the demand for sprockets that will operate smoothly and which can also be economically produced in the foundry.

The important features of these standard sprockets may be mentioned as follows: The inside width of the chain-roll is made ⅛-inch wider than the width of the tooth *D* to provide the necessary clearance. From the points *C* to *D* and *A* to *B* the only function of the tooth is to guide the chain to the seat. Any extra metal outside of the pitch diameter merely adds to the weight of the tooth without strengthening it, and to avoid excessive weight the design shown in the accompanying illustration was adopted. Here it will be seen that the pattern is cut away in such a manner that a sprocket is produced with a cross-section in which useless metal is eliminated. The radius *E* on the tooth is slightly less than the radius of the chain-roll, the radius of the chain-roll being made equal to the distance from the pitch circle to the root diameter of the sprocket. A fillet with a radius slightly less than the radius of the chain-roll should be used on the sprocket patterns at the point *E* in order to allow the chain to seat itself on the root circle and the tooth of the sprocket at the same time. It is not good practice to have the radius *E* equal to the radius of the chain-roll owing to the inevitable roughness of the castings. The writer's experience has shown that the dimensions outlined in the Data Sheet will give satisfactory results for sprocket chains used on all classes of machinery.



Nine-tooth Sprocket for No. 55 Chain, showing how Weight is reduced by removing Unnecessary Metal

* * *

The energy spent in getting even is an investment that pays poor dividends.

* With Data Sheet Supplement.
† Address: 613 S. Second Ave., W., Newton, Ia.

STATISTICS OF BICYCLES, MOTORCYCLES AND PARTS FOR 1909

Statistics for the bicycle, motorcycle, and parts industry have been issue by the Bureau of the Census, Department of Commerce, Washington, D. C. The number of bicycles made decreased from 1,182,691, valued at $23,656,487, in 1899, to 250,487, with a value of $3,740,923, in 1904, and 233,707, valued at $3,228,189, in 1909, while the output of motorcycles increased from 160, valued at $33,674, in 1899, to 2328, valued at $359,180, in 1904, and 18,628, with a value of $3,015,988, in 1909.

The evolution of the bicycle from primitive and unserviceable types to a useful and attractive means of travel may be said to have taken place between 1868 and 1890; and its perfection and standardization into practically one form of structure, the modern "safety," between 1890 and 1895. During this latter period the popularity of the bicycle became so widespread that the industry grew very rapidly, but after about 1897 it began to decline.

In 1889 there were twenty-seven establishments engaged in the industry, which gave employment to an average of 1797 wage earners and reported products valued at $2,568,326. At the census of 1899, after the industry had begun to decline, the average number of wage earners was nearly ten times and the value of products more than twelve times as great as in 1889.

During the five-year period ending with 1904 the industry declined very rapidly. The number of establishments decreased from 312 to 101, or 67.6 per cent; the average number of wage earners from 17,525 to 3319, or 81.1 per cent; the value of products from $31,915,908 to $5,153,240, or 83.9 per cent; and the value added by manufacture (value of products less cost of materials) from $15,123,857 to $2,525,094, or 83.3 per cent.

A considerable recovery of the industry as a whole is indicated by the statistics for 1909. While the number of establishments in that year shows a decrease from the number in 1904, the average number of wage earners increased 1118, or 33.7 per cent, and the value of products, $5,545,327, or 107.6 per cent. The most important factor in the renewal of activity in the industry has been the growing demand for motorcycles.

	Number or Amount			Per Cent of Increase*	
	1909	1904	1899	1899–1909	1904–1909
Number of establishments.	95	101	312	−69.6	− 5.9
Persons enenged in the industry.....	5,017	3,761	19,768	−74.6	33.4
Wage earners (average number).....	4,437	3,319	17,525	−74.7	33.7
Capital........	$9,780,102	$5,883,458	$29,783,659	−67.2	66.2
Wages.........	2,908,199	1,971,403	8,189,817	−64.5	47.5
Value of products........	10,698,567	5,153,240	31,915,908	−66.5	107.6

Machinery

* A minus sign (—) denotes decrease.

As already stated, the industry was declining at the census of 1899, yet more than 1,000,000 bicycles were made in that year. The output in 1904 was barely one-fifth as great, and there had been a further decline by 1909. No tandem bicycles or tricycles for adults were manufactured in 1909, although their manufacture had been reported at the two preceding censuses. On the other hand, the development of the motorcycle branch of the industry has practically all taken place within the decade 1899-1909, and more particularly in the second half of the decade.

MAKING A FIXTURE FOR MACHINING SAW-TOOTH BLADES

In making dies, jigs and fixtures, a considerable part of the time involved is occupied in changing the work from one machine to another, and getting it accurately set up for the different machining operations. It is the purpose of this article to describe the operations involved in making a fixture for machining teeth to be used in saw blades of the "inserted tooth type." The universal shaping machine made by the Cochrane-Bly Co., Rochester, N. Y., was used for this purpose. This machine was especially designed for work of this kind and effects a material saving through enabling practically all machining operations to be performed at a single setting of the work.

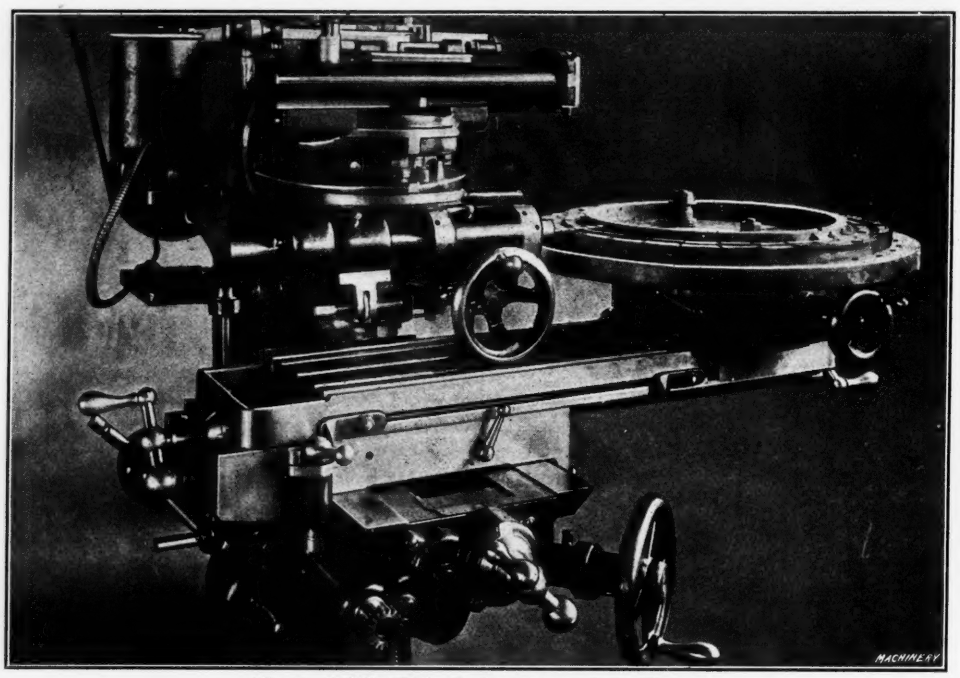


Fig. 1. Drilling Holes in the Flange of the Fixture

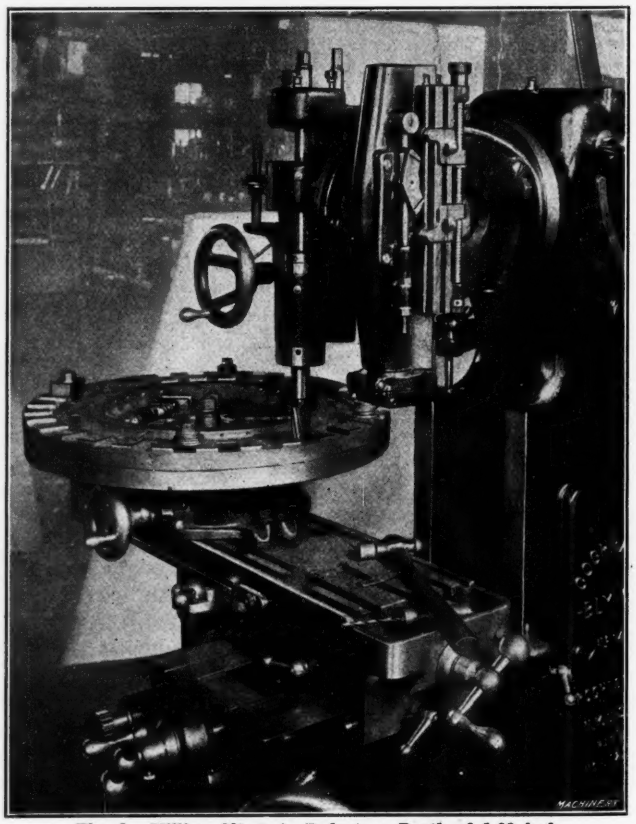


Fig. 2. Milling Alternate Pads to a Depth of 1-32 inch

After the casting from which the body of the fixture was made had been turned up on a lathe, it was set up on the circular table of the universal shaper. The first operation performed on this machine consisted of drilling thirty holes around the flange of the fixture. For this purpose, the head of

the machine was swung to a horizontal position, as shown in Fig. 1, so that these drilling operations could be performed by a drill carried in the "milling spindle" of the machine. It will be evident that these thirty holes are spaced twelve de-

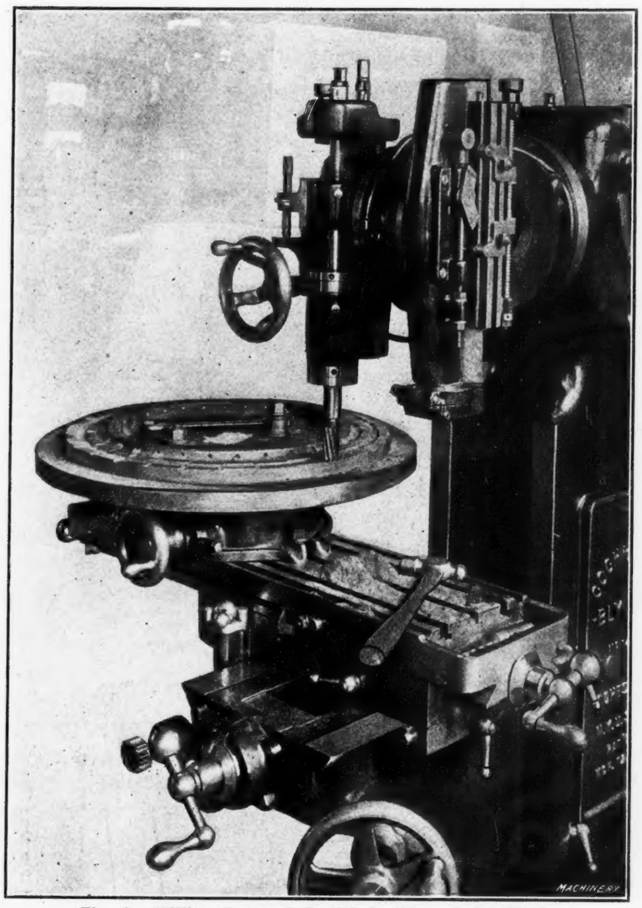


Fig. 3. Milling Recessed Radial Sections of the Fixture

grees apart and the indexing was done with the graduated dial on the circular table.

The next operation consisted of machining the pads on the fixture. The face of the casting was divided into thirty sec-

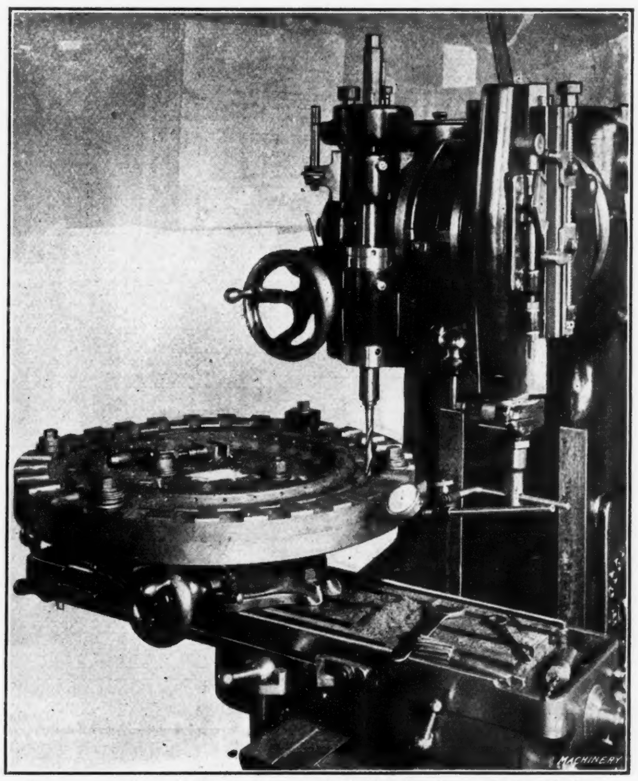


Fig. 4. Drilling Holes in Recessed Radial Sections of the Fixture

tions, fifteen of which were milled in this operation to a depth of 1/32-inch below the faces of the alternate sections. Fig. 2 shows the method of milling these pads. For this purpose it will be seen that the head of the machine was brought back to the vertical position, and an end-mill inserted in the spindle. These pads come midway between the holes that were drilled in the preceding operation, and are located twelve degrees from each other.

After these milling operations were completed, a ring which was turned to the proper size to fit the outside of the raised section on which the pads were milled, was placed on the fixture. After this ring was clamped in position, thirty recesses were milled on its face, as shown in Fig. 3. These recesses are 1¼-inch wide by 2 inches long by ¼-inch deep. They were milled by the same cutter which was used for milling the pads in the preceding operation. The next step consisted of drilling a hole at the center of each of the thirty recesses, for screws which are used for holding the tooth blanks during the machining operations. These holes are ½ inch in diameter by 2½ inches deep. The feed for the drilling was obtained by means of a vertical movement of the milling slide, as shown in Fig. 4. After the holes were drilled, they were tapped to receive the screws. Referring to Fig. 4, it will be seen that a dial test indicator is held in the extension toolpost of the slotter head. The use of this indicator makes it possible to determine the accuracy of the alignment of the fixture at all times, without making it necessary to change the location of the milling cutter. The final step consisted of milling the

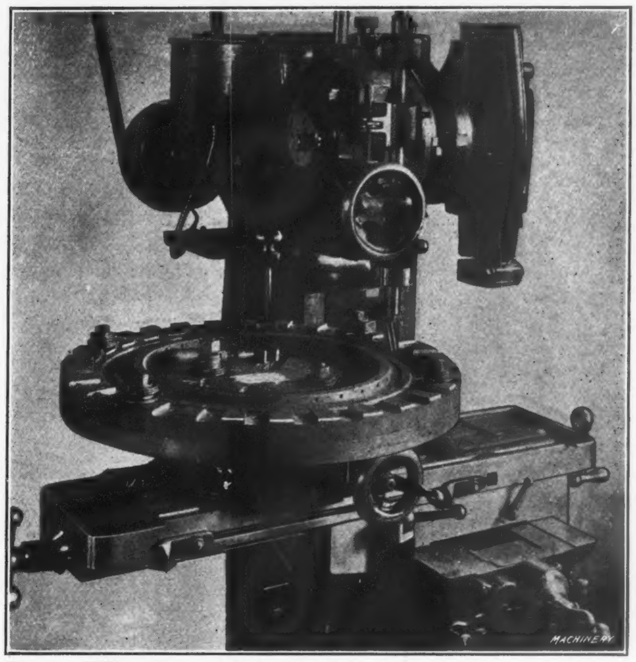


Fig. 5. Milling Faces of Pads Straight. Alternate Pads are 0.030 inch longer than Adjacent Pads

vertical faces of the thirty pads that were formed around the ring (see Fig. 5:). These faces were milled straight—not radial—and each alternate pad was left 0.030 inch longer than the adjacent pad.

This fixture is used on the faceplate of a thirty-inch lathe for machining the anchor faces of the thirty saw teeth at one operation. The time saved through making this fixture on the Cochrane-Bly universal shaping machine will be readily appreciated when it is known that all five operations were completed without requiring more than one setting of the work. In addition to this, it was only necessary to move the circular table once, which was done between the drilling and the first milling operation, the circular table being moved from one end of the machine table to the other. This universal shaping machine was described in the October, 1912, issue of MACHINERY, so it is unnecessary to include a description of its mechanical details here.

* * *

When you walk into a factory where you hear the manager say: "I have a fine lot of men out there in the shop and I'd hate to lose any of them," and you then walk out into the shop and hear the men say: "We have good jobs here and we'd hate to be laid off," you may be pretty sure that you have walked into a concern where neither the N. A. M. nor the I. W. W. would be able to stir up distrust, discontent or strife.

ON DETERMINING SHAFT DIAMETERS

CHARTS FOR SIMPLIFYING THE CALCULATIONS OF SHAFTING FOR COMBINED TORSION AND BENDING STRESSES

BY W. G. DUNKLEY*

Numerous cases arise in the design of machinery in which shafts are under combined torsion and bending stresses. A specific case is that of a driving wheel which is overhung on the shaft in the manner illustrated in Fig. 1. In such a case it is not sufficient to design the shaft merely to withstand the torsional stress; it must be designed to withstand the combined stresses of torsion and bending. Let T represent the twisting moment on such a shaft and M the bending moment. For these conditions, it is usual to design the shaft as though it were under an equivalent twisting moment T_1, the value of which is given by the following formula:

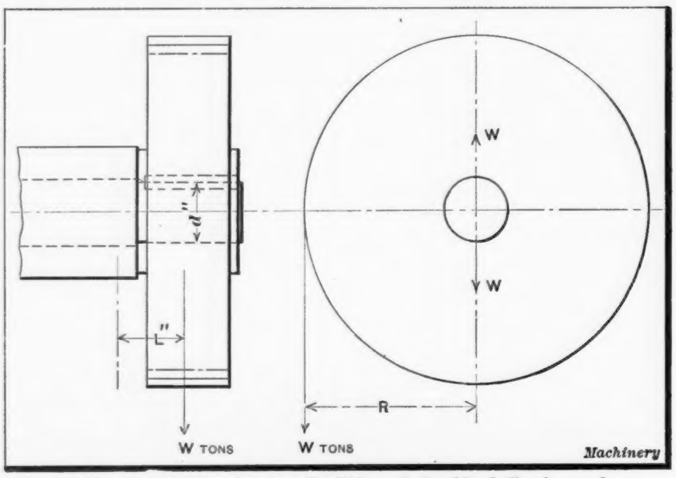


Fig. 1. Diagram showing Condition of Combined Torsion and Bending in Shaft

$$T_1 = M + \sqrt{M^2 + T^2} \quad (1)$$

This does not mean that the shaft is actually under the twisting moment T_1, but theory shows that the value of the stress obtained by this formula is equivalent to the combined effect of the twisting and bending moments on the shaft. There are other points connected with the theory of combined stresses which will not be taken up here, but the preceding explanation will probably be of interest to those to whom the formula is new.

In order to find the required size of a shaft which is under combined bending and torsional stresses, it is first necessary to obtain the values of the bending moment M and the twisting moment T, which are then substitued in the formula to find the equivalent twisting moment T_1. The required diameter of the shaft can then be calculated in the usual way, from the formula of a shaft under torsion:

$$T_1 = \frac{\pi f D^3}{16} \quad (2)$$

where f = safe stress in tons per square inch;
D = diameter of shaft in inches;
T_1 = equivalent twisting moment in inch-tons.

From Equation (2) we find:

$$D = \sqrt[3]{\frac{16T_1}{\pi f}} \text{ inches}$$

The charts illustrated in Figs. 2 and 3 have been developed to do away with the necessity of calculating the value of T_1 from Equation (1) and of D from Equation (2). The use of these charts makes it possible to obtain the required shaft diameter directly from the values of the bending and twisting moments on the shaft. The method of obtaining the values of M and T will vary according to the circumferences of the shafts, but we will take the particular case of the overhung driving wheel shown in Fig. 1 as an example.

Let W = safe load in tons on the teeth of the wheel;
R = radius of the wheel in inches;
T = twisting moment on the shafting = WR inch-tons;
L = distance in inches from middle of wheel to one inch inside of bearing;
M = bending moment on shaft = WL inch-tons.

This value of M is not strictly accurate since W is the tangential load on the tooth and not the actual load. If a is the angle of obliquity of the action of the teeth of the wheel, then the actual load on the teeth is $\frac{W}{\cos a}$, and a more accurate value of M would be $\frac{WL}{\cos a}$. The value of the bending moment obtained from the equation $M = WL$ is quite accurate enough for the present design, however.

If we substitute a value of 4 tons for f in the equation

$$T_1 = \frac{\pi f D^3}{16},$$

we get

$$T_1 = \frac{4\pi D^3}{16} = 0.7854D^3$$

D Inches	T_1 Ton Inches	D Inches	T_1 Ton Inches	D Inches	T_1 Ton Inches
1	0.701	3.5	30.07	6.0	151.6
1.5	2.367	4.0	44.89	6.5	192.6
2.0	5.611	4.5	63.92	7.0	240.6
2.5	10.95	5.0	87.68	7.5	295.9
3.0	18.94	5.5	117.2	8.0	359.1

From this we obtain values of D and T_1 as presented in the accompanying table. These values are then plotted to a suitable scale that gives a curve from which the value of D for any value of T_1 may be obtained. It is advisable to divide the chart into two portions according to Figs. 2 and 3. Fig. 2 covers conditions for shafts up to 4 inches in diameter, and Fig. 3 for shafts from 4 to 8 inches in diameter. However, the arrangement of the charts can easily be modified to meet the requirements of different cases. The method of construct-

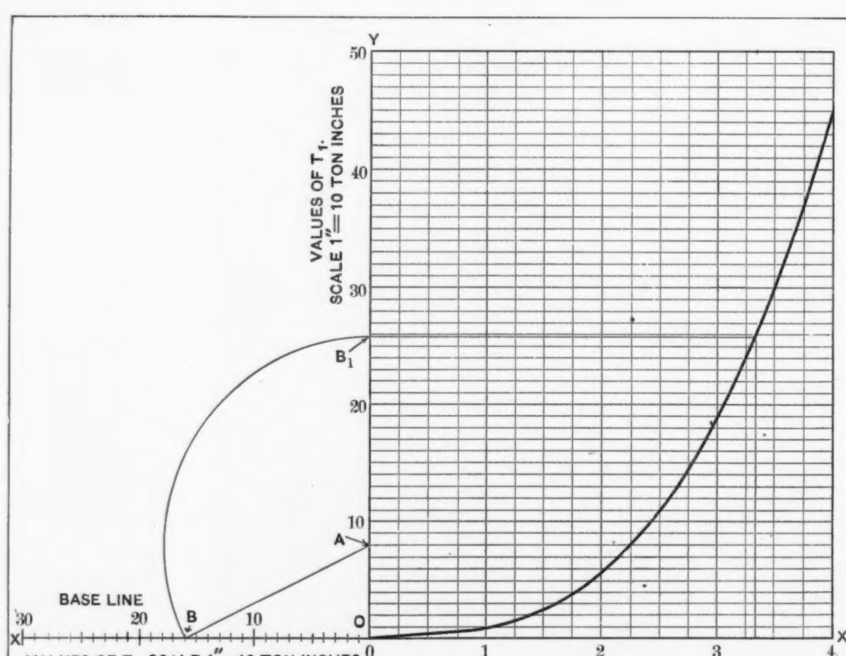


Fig. 2. Chart for obtaining Shaft Diameters from 0 to 4 Inches under Combined Torsion and Bending

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ing the charts is as follows: The values of T_1 are plotted vertically on the line OY, and the base line OX, on which the shaft diameters are laid out to the right of the vertical line, is extended to the left in the manner shown. In order to obtain values of the equivalent twisting moment T_1, the bending moment M in inch-tons and the twisting moment T in inch-tons are obtained in the manner previously described. The point A is then located on the line OY so that OA is equal to the value of M. Point B is located at such a distance from the vertical line OY that OB represents the value of the twisting moment T to the same scale. With A as a center and AB as a radius, an arc of a circle is drawn which locates the distance AB_1 on the vertical line OY. The distance OB_1 then represents the value of the combined bending and twisting moments T_1 on the shaft to the scale which was adopted in drawing the diagram. In order to show that OB_1 equals T_1, we know that $OA^2 + OB^2 = AB^2$ or substituting the equivalents of these sides we have

$$M^2 + T^2 = AB^2.$$

Therefore,

$$AB_1 = AB = \sqrt{M^2 + T^2}$$
$$OB_1 = OA + AB_1$$
$$OB_1 = M + \sqrt{M^2 + T^2} = T_1.$$

In explaining the application of this method, we will assume an example the conditions of which are illustrated in Fig. 1.

Let $W = 2$ tons;
$R = 8$ inches;
$L = 4$ inches.
Then $T = WR = 16$ inch-tons;
$M = WL = 8$ inch-tons.

In Fig. 2 we will lay off the distance OA to represent 8 inch-tons and OB to represent 16 inch-tons; we then get the value of OB_1 by scaling off the distance on the vertical line OY and the diameter of the corresponding shaft is seen to be approximately 3 5/16 inches. If a case arises in which there is only a twisting moment on the shaft, we have $M = 0$. Consequently

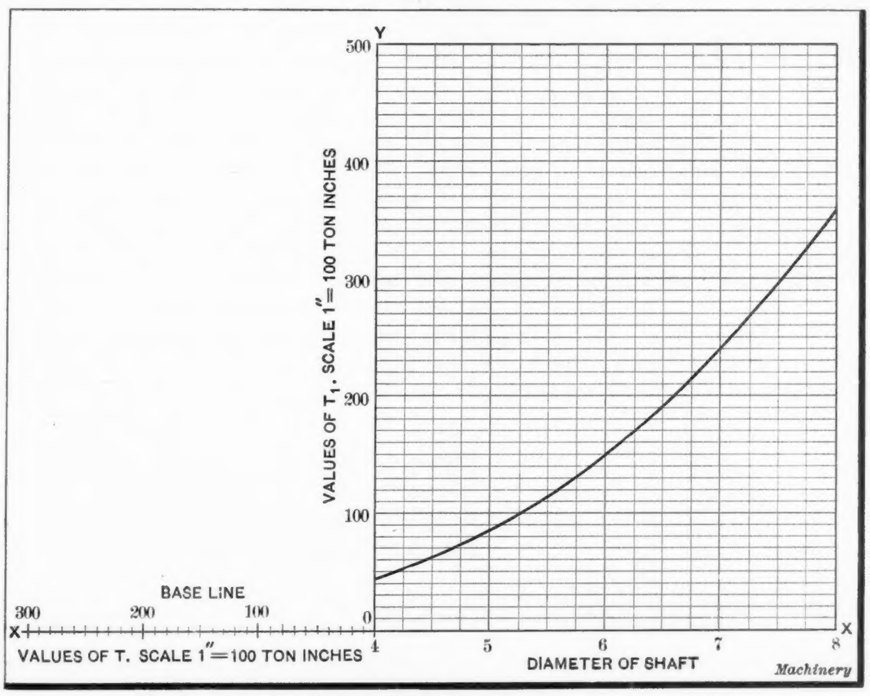

Fig. 3. Chart for obtaining Shaft Diameters of 4 to 8 Inches under Combined Torsion and Bending

$T_1 = T$. Also if there is only a bending moment on the shaft, we have $T = 0$, which gives the value of

$$T_1 = M + \sqrt{M^2 + T^2} = M + \sqrt{M^2} = 2M \ (T = 0).$$

This shows that the chart may be applied for the following cases. (1) For shafts under combined twisting and bending moments: $T_1 = M + \sqrt{M^2 + T^2}$. (2) When the shaft is only subjected to a twisting moment: $T_1 = T$. (3) When the shaft is only subjected to bending moment: $T_1 = 2M$. Case (1) is by far the most important, and the one most frequently encountered in machine design, as it seldom happens that a shaft is subjected merely to twisting or merely to bending moments.

Without the use of the chart, the calculation of the diameter of a shaft in which there are combined twisting and bending stresses, would be as follows:

Let $M = 8$ inch-tons;
$T = 16$ inch-tons;

Then $T_1 = M + \sqrt{M^2 + T^2} = 8 + \sqrt{8^2 + 16^2} = 8 + \sqrt{64 + 256}$
$= 8 + 17.88 = 25.88$ inch-tons.

From Equation (2) we have $T_1 = \dfrac{\pi f D^3}{16}$. From this we get

$$D^3 = \frac{16 T_1}{\pi f}.$$

Substituting 4 tons for f, we get

$$D^3 = \frac{25.88 \times 16}{3.142 \times 4} = 32.90$$
$$D = \sqrt[3]{32.90} = 3.205 \text{ inches.}$$

The value obtained from the chart is slightly less than 3 5/16 inches. This illustration shows the saving of time and effort which is effected by the use of the chart. It will, of course, be understood that the construction lines for combined twisting and bending moments on the shaft need not be drawn; they are merely presented here to indicate the accuracy of the theory upon which this method has been developed.

* * *

SMALL MANUFACTURERS' EXHIBITS AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION

The Panama-Pacific International Exposition which will be held in San Francisco in 1915 announces through Mr. A. M. Hunt, Chief of the Department of Machinery Exhibits, that arrangements will be made by which small exhibitors can cooperate and show their exhibits in one booth at greatly reduced expense. The action was taken as the result of corresponding with manufacturers; many of the smaller ones have expressed a belief that they could not afford to exhibit because of the heavy expense of shipping the goods to San Francisco and maintaining a person in charge of a booth during the long term of the exposition. Such manufacturers will be permitted to club together and make their individual applications for space. They will be assigned space in such a way that their exhibits may be grouped together and handled and cared for by one person. By clubbing together the expense will be greatly reduced and the effectiveness of the exhibit enhanced. If shown in the manner prescribed each exhibit will be considered by the Jury for Awards in the same manner as if exhibited independently.

The management suggests that it will be unwise to include in any group directly competitive articles. On the other hand, groups of exhibitors whose products are of a non-competitive nature and such as can be harmoniously shown in conjunction should combine. For example, a manufacturer whose product is confined almost exclusively to the manufacture of ball and roller bearings could combine with certain other manufacturers in which ball and roller bearings of different forms and styles are a prominent feature, such as ball bearing jacks, and other appliances in which anti-friction bearings greatly improve the efficiency and wearing qualities. Full information will be furnished by the management to all manufacturers interested in the proposed cooperative plan.

* * *

An international exhibition will be held in Manchester, England, from May to October, 1914. This exhibition will be especially representative of the industries in which the North of England is engaged. The total area covered by the exhibition will be 90 acres and a great deal of space will be given to the machinery section, where it is expected that many classes of machinery will be shown in motion and to the best advantage.

SOME SLOTTING MACHINES AND TOOLS USED IN THE POND SHOPS

METHODS OF EQUIPPING AND TOOLING SLOTTERS FOR GREATER EFFICIENCY

BY ALFRED SPANGENBERG*

In considering the problem of increasing production on any machine tool, attention should be directed to features that will insure speed, accuracy and convenience in the machine itself, as well as to the character of the tool equipment, if the highest efficiency is to be attained. Features that will enable the operator to select instantly, or have definite knowledge of any particular speed, feed, or depth of cut are absolutely essential in the modern shop. The principles just laid down are embodied to a large extent in the slotting machine tools and methods illustrated and described in the following article, which shows the general practice on work of this character as followed at the Pond Works of the Niles-Bement-Pond Co., at Plainfield, N. J.

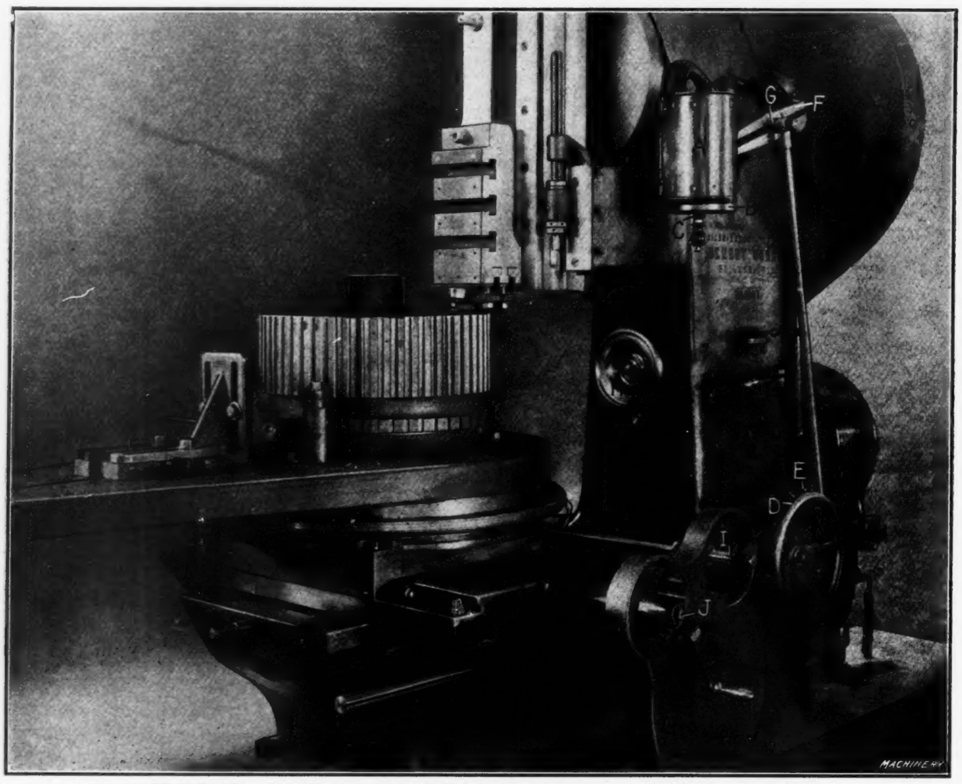

Fig. 1. Bement Slotter with Special Attachments to facilitate Operation

Referring to Fig. 1, it will be observed that the Bement slotter shown is motor driven and provided with a controller *A*, conveniently located, for starting, stopping and regulating the cutting speed of the ram. This controller is provided with a graduated brass plate *B* fastened to the controller frame, and a pointer *C* attached to the handle, by means of which any desired number of strokes per minute, within the range of the motor speeds, is accurately and instantly obtainable, the graduations reading in number of strokes of the ram per minute. A table, not shown, gives the cutting speed of the ram in feet per minute for any given length and number of strokes per minute.

Another special feature of this controller is that it is wired to the motor armature in such a way that whenever the controller handle is moved into the "off" position, the effect is to make the motor act as a powerful brake and stop the ram almost instantly. This is a great advantage, for while the machine is provided with a hand operated friction brake, the dynamic brake is more effective and does not require any extra motion on the part of the operator. Fig. 2 shows a wiring diagram from which it will be seen that the only change in the standard controller is the addition of the two contacts *A'* and *A"* and the bar *B* which is attached to the controller drum. The dynamic resistance is obtained by connections to the regular field resistance box, enough resistance being used to prevent excessive sparking at the motor brushes. This dynamic brake can, of course, be applied to any motor-driven machine tool using direct current and is particularly valuable on such machines as boring mills, drills, and lathes.

Referring again to Fig. 1, it will be observed that the handwheel *D* is machined flat on its periphery in order to provide for graduations (reading in 0.002 inch) the purpose of which is to facilitate accurate longitudinal settings of the table and work without stopping to make other measurements. A pointer *E* attached to a rigid support marks the starting point. This device is particularly valuable on work similar to that illustrated, which is a large steel gear, the teeth of which are being roughed out, after which the gear is to be finished in a gear cutter. It might be stated that the object of roughing out the teeth on the slotter is to effect a saving on the more expensive rotary cutters. The depth of cut being known, the required number and fractional parts of handwheel turns necessary for each cut are easily and quickly determined. A chalk mark made at the line representing the final depth of cut indicates to the operator when to disengage the power feed and finish by hand feed.

To facilitate accurate setting of the feeds, the rocker arm *F* is graduated on its upper face and a line on the stud bushing at *G* acts as a pointer. Each graduation on the rocker arm represents one ratchet tooth of feed. Another convenient feature for obtaining minute hand adjustments of the ram when setting cutters or adjusting strokes, is the handwheel *H* which is keyed to an extension of the intermediate driving gear shaft. As the illustration indicates, the handwheel is of the web form so that there is no danger of the operator being injured when the machine is in motion.

Special Tools and Tool-holders

In the illustration Fig. 3 some special tool-holders for the rapid and convenient machining of certain machine tool parts are shown. The general character of the work machined by the gang tool-holders *A* and *B* is suggested by their design. In the first case two tools, and in the second case four tools are available for simultaneous operation. In the same illustration at *C* is shown a special splining tool-holder for cutting keyways of various widths to the bottom of blind holes. It is necessary, of course, in work of this char-

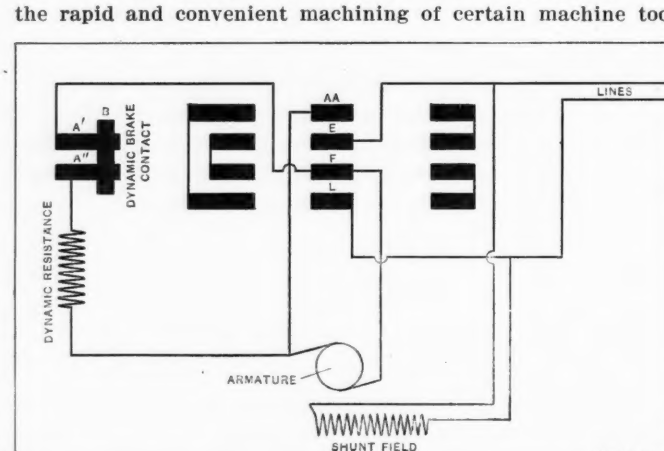

Fig. 2. Diagram illustrating Special Method of wiring the Controller

* Address: 951 W. Fifth St., Plainfield, N. J.

acter to provide a suitable "run-out" for the cutter in order to prevent choking from the chips and consequent breaking of the tool point. The run-out may be formed either by drilling a suitable hole in the casting to be splined, or by turning a recess at the bottom of the blind hole.

The details of this tool are more clearly shown at *A* in

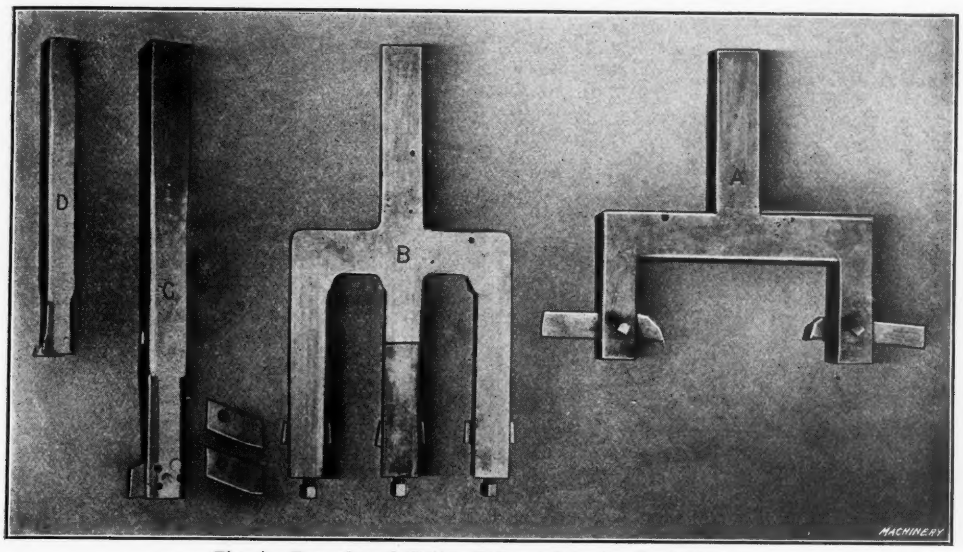

Fig. 3. Examples of Slotter Tools used in the Pond Shops

Fig. 4, an inspection of which will show that the tool proper is hinged at *B* so that a relief for the tool is provided during the return stroke. Spring *C* keeps the cutter in the normal position, and cutters of various widths may be inserted in the slot *D*. The purpose of screw *E* is to keep the cutter in its proper position in the slot. Illustrated at *D* in Fig. 3 and shown in detail at *F* in Fig. 4 is a tool-holder for cutting internal ratchet wheels and small internal gears. The construction is so simple that little explanation is necessary. The cutting tool is shaped to be a driving fit in the dovetail slot in the clapper *G*.

For small work of a general character the tool-holder shown in Fig. 5 is a most useful adjunct to the slotting machine. As in the case of the two holders just described, the principal feature of this one is to provide a relief for the cutting tool during the return stroke. While there is, of course, provision for tool relief in the regular ram apron, it is well known that for small cutting tools this relief is too stiff to be effective. It will be seen from the illustration that the clapper *A* which carries the cutting tool, is of trunnion form and is forged and machined out of the solid to insure strength. Both ends of the trunnion are tapped so that the set-screw *B* which clamps the cutting tool may be used in either side as the character of the work may demand. Other details of this holder are clearly defined in the illustration.

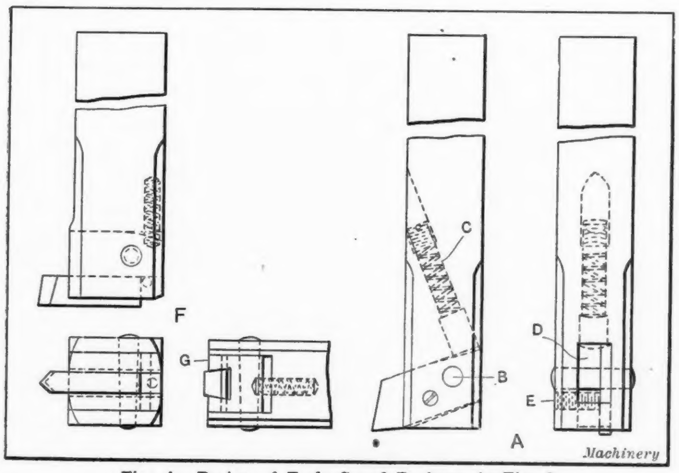

Fig. 4. Design of Tools C and D shown in Fig. 3

Fig. 6 shows a tool and holder for roughing out the teeth of large internal gears. This double cutter, as will be apparent, cuts two teeth at a time, thereby saving about one-third of the time usually required. The advantage of this holder is that the tool can cut close to a horizontal surface.

A special graduating tool for marking the graduations on lathe tailstocks is shown in Fig. 7. Before this tool was made it took about ten minutes, actual machining time, to graduate a tailstock. A single pointed tool was used, and the table had to be indexed for each line and the stroke adjusted for different lengths of lines. The work is now accomplished in one stroke of the ram and in a fraction of the former time.

Special Appliances

One of the most particular jobs the slotting machine has to handle in a machine tool shop is the cutting of large internal and external gears. It is the general practice for work of this character, to provide a special indexing fixture similar to the one illustrated in Fig. 1 for spacing the cuts. Again, a special gear may have to be cut for which there is no index plate available, in which case it is customary to place compound gears on shafts *I* and *J* and index by means of a graduated dial and pointer, the principle being similar to that used on a milling machine dividing head. Shaft *J* is merely used as a stud for the back gear. In either case inaccuracies in spacing are liable to occur and these may readily be detected by the use of a fixture as illustrated in Fig. 8. From an inspection of Fig. 8, it will be seen that the scheme is to support the meshing pinion on a stud *A*, the center distance between the pinion and gear being ac-

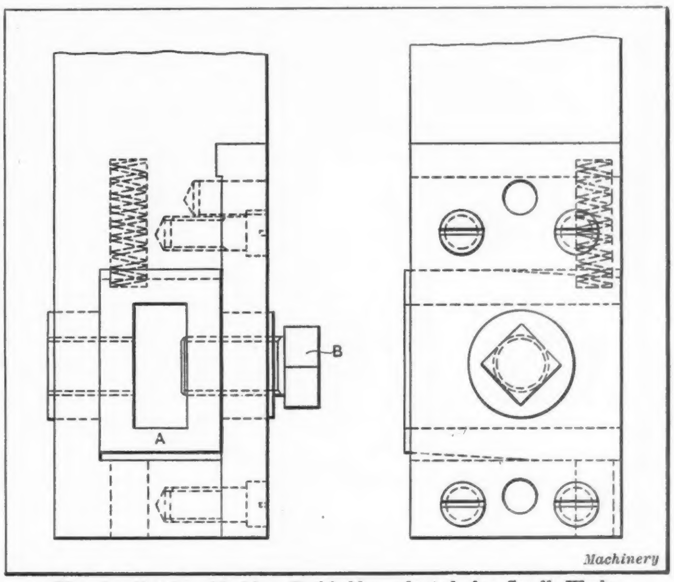

Fig. 5. Slotting Machine Tool-holder adapted for Small Work

curately fixed and maintained in the swiveling arm *B*. By rolling the pinion around the cut gear any inaccuracies in spacing or depth of cut are easily and quickly determined and remedied by recutting. Hole *C* is for inspecting. Of course, where accurate indexing fixtures are used and the depth of cut carefully made, this "doctoring" is seldom necessary.

In slotting machine practice it is necessary, in many instances, to use an auxiliary table for supporting work that is too large to be handled by the regular slotter table, such a case being illustrated in Fig. 1. These auxiliary tables are usually provided with a centering pin for locating the work. A very convenient form of centering pin, which can easily and quickly be inserted or removed and which has no nut for withdrawing the pin, is shown in Fig. 9. The usual type has a nut which often interferes with the work.

In conclusion, it may not be amiss to suggest a change in the standard design of slotting machine tables from the circular form to the square or rectangular type. The writer has discussed this feature with a number of expert slotting machine operators and it seems to be the consensus of opinion

that the square table would be a decided advantage in that it would, in many instances, permit the more convenient clamping of the work, and this form would frequently eliminate the necessity for an auxiliary table. The objection that the corners of a square table might interfere with its rotation by striking the frame of the machine would hold good only in very rare instances where the table has to be rotated close to the frame.

* *

THE HABIT OF OBSERVATION

The ability to observe accurately and quickly is most valuable to men in the mechanical field, yet few men possess this faculty to any high degree. Perhaps that is the reason why those who do usually—to use a common expression—get ahead. The habit of accurate observation can be developed by simple methods. One man used to pass a store window, glance into it for a few seconds, pass by, take up his note book and jot down a brief account of what he had seen; then he would go back and compare his notes with what was actually exhibited in the window. By this simple means he developed ultimately so great an ability of rapid and accurate observation that small details would become fixed in his memory, whenever he observed anything with the intention of retaining the impression in his mind. Probably better methods for training the faculty of observation may be devised, but the example mentioned simply shows the opportunity open to anyone who recognizes the value of this training of the mind and has perseverance enough to acquire the habit of observing.

* * *

Secretary Redfield, of the U. S. Department of Commerce, has instructed the Bureau of Standards to make a study of the causes of railroad accidents resulting from broken car-wheels and axles. The reason for this investigation is that it has been found that about four times as many wrecks are caused by broken car-wheels as by broken rails, and that twice as many wrecks are caused by broken axles as by broken rails.

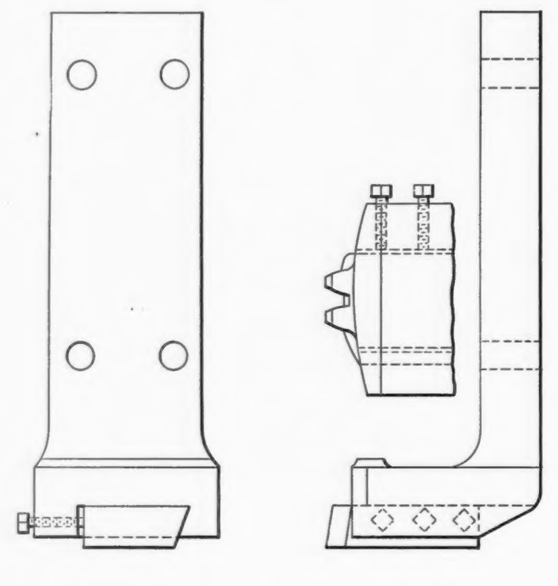

Fig. 6

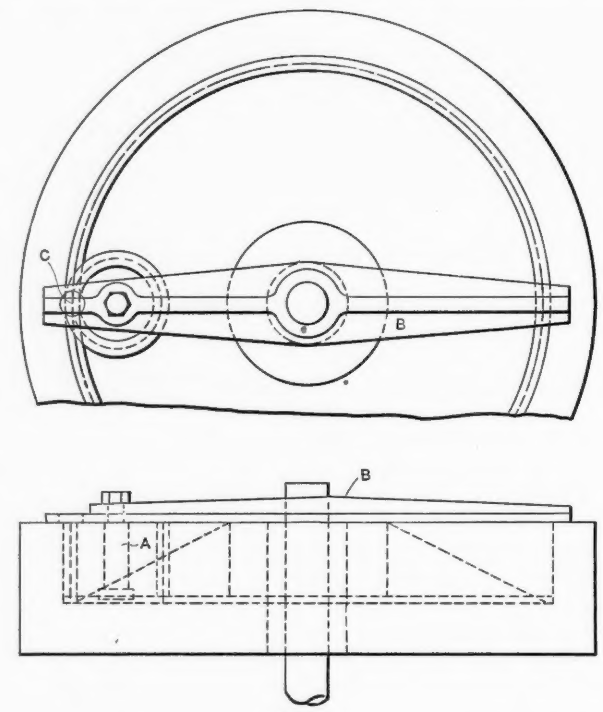

Fig. 8

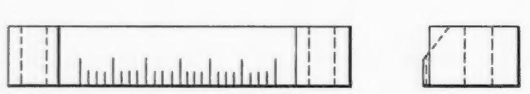

Fig. 7

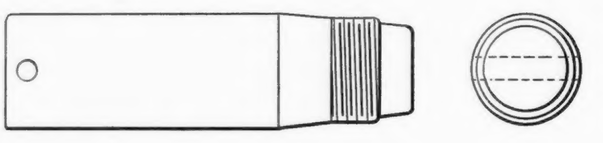

Fig. 9

Machinery

Fig. 6. Tool and Holder for roughing out Teeth of Large Internal Gears
Fig. 7. Special Tool for graduating Lathe Tailstocks

Fig. 8. Tool for testing the Accuracy of Gear Teeth cut on a Slotter
Fig. 9. Convenient Form of Centering Pin for Auxiliary Slotter Table

A TEN-CENT PROTECTIVE SYSTEM

BY DUGALD MC KILLOP*

One of the most useful forms of welfare work which can be conducted in any factory is that of providing some voluntary or involuntary form of insurance whereby employes will be encouraged to make provision for periods of adversity at a time when their earnings are more than adequate to provide for their actual needs. The following description outlines the work of the Thomson-Houston Mutual Benefit Association of the General Electric Co., Lynn, Mass. This organization is conducted on a basis that insures protection for its members at a rate which never exceeds ten cents a week, and is usually considerably less than this.

The general plan of organization is as follows: The company appoints one officer to represent it, who is known as the general chairman, and whose duties are to act, if necessary, as a judicial intermediary between employer and employe, and to keep things running in accordance with the provisions of the constitution and by-laws. Under ideal conditions, however, the general chairman acts largely in an advisory capacity. The association is made up of sections or units of 150 members, each section having as officers a chairman, a vice-chairman and a secretary-treasurer; these three officers—with six other elected members—constitute a board of directors. The officers are elected annually by the members of each section. At the first meeting, three directors are elected for a period of one year and three for two years; and thereafter, three directors are elected annually to serve two years. The chairman and secretary are chosen annually.

In the important matter of finance, the sections are conducted independently of each other, insofar as sick benefits are concerned. When formed, the first effort of a section is to accumulate the sum of $200 which is banked as a reserve fund. Assessments are then continued until the fund reaches $300,

* Address: 109 Pine Grove Ave., Lynn, Mass.

when dues are discontinued until the calls upon the treasury reduce the sum in hand to $200, at which time dues are again levied. By having this reserve in hand, provision is made for a possible epidemic of sickness or a rush of accidents.

An applicant for membership in a section voluntarily signs an application blank which involves a pledge to abide by the constitution, and upon vote of the directors he may be elected without further formality. If admitted, he is so notified, and thenceforth the secretary-treasurer practically takes charge of the new member, collecting his dues and looking after his claims for disability. Any person over fourteen years of age who has been employed by the company for one month is eligible for membership in the junior grade, and any person over eighteen years may become a member of the senior division. The dues and benefits of the junior division are one-half those of the senior division. The initiation fee for senior membership is fifty cents and the dues are ten cents per week. A newly elected member must pay dues one month before he becomes a full member entitled to benefits in case of illness. No medical examination for entrance is required.

The sick benefits paid are at the rate of $6 per week for men and $5 per week for women, for fourteen weeks per year, no payment being made for the first week's illness. If, on account of a lingering disability, a member is unable to work, he is entitled to equal benefits for a second year, but if he does not return to work after this period his connection ceases.

Through the office of the general chairman, a levy at the rate of ten cents per member per month is made on all sections until a standing fund of $1000 is secured. Assessments are continued until the fund reaches $2000, when they are discontinued and only resumed when the drafts on the treasury bring the fund down to $1000. Additional emergency benefits are allowable in cases of proven need. The death benefit or life insurance is $100, payable to whoever is designated by the applicant, or to the legal heirs. It is important to note that the life insurance is provided by what may be called an indirect tax, the money being paid by the section treasurers from the funds in hand. The regular ten-cent weekly levy on the man in the shop or office really pays all the bills; and though this may be continuous every week of every year, a member seldom grumbles, for he knows that ten cents is the maximum. If weekly collections were not continuous and special assessments were made in cases of death, there would be dissatisfaction, as was found in the early experience of the organization. The constitution as it exists today is the result of many amendments. Each section compensates its own members in case of disability, but the death risks are pooled in order to distribute that heavy line of liability evenly.

Even a partial record of the things accomplished by this mutual benefit association shows the remarkable possibilities for good of such an organization. Started in August, 1902, by the end of 1904 there were fifteen sections in operation. While 150 is the maximum membership for a section, several sections were started with a small membership and then gradually built up by solicitation. Some sections have paid dues at the rate of ten cents per week steadily. The best record of any section for a period of years showed an average cost per member of only $2.25 per year, and in this section there was one period of fourteen months when it was not necessary to collect dues. In the meantime, adequate protection was afforded the members. The great success attained would not have been possible except for the friendly attitude of the factory management, and its unobtrusive but real patronage.

The total number of deaths from 1902 to the close of the last association year was 212; the total receipts from dues, $130,064.64; and the disability benefits paid, $102,269.79, the death benefits paid being over $20,000. The success of the association has been cumulative, the good done in individual cases being attested to by the beneficiaries. This has advertised the association and today it is the popular thing to join the "Mutual Benefit." The organization is growing so fast that new records are being made each year. At the close of the last annual tabulation the membership in forty-five sections was 5911, but in April, 1913, it had risen to 6118, or about one-half of the total number of employes. There are six female sections.

The steady growth of the association is assured, as the organization is far beyond the experimental stage. Numerous specific instances of the good cheer and indispensable aid given to those prostrated by grief or afflicted by sickness attest to the value of its work. Some join because they wish to endorse the system rather than for personal protection, but there is no class distinction—laborer and foreman belong to the same section. An effort is made to have the members of any one section drawn from the same building or department, but this has been found extremely difficult to enforce, as new buildings cause a readjustment of shop departments, and it frequently happens that members of a section are suddenly moved a mile or more from their original location. To remedy this difficulty, a system of easy transfer is operated, by means of which the original rights of a member are conserved without making it necessary for the secretaries to go into many different buildings in carrying on their work.

Four features of the work of this association that could be duplicated in almost any factory seem to have been responsible for its signal success:

1. An equitable plan of collecting dues and making disbursements. Formerly, if workman A was in trouble a subscription list was passed around among his mates and a snug sum of money collected for him. Perhaps within a few days, workman B met with a bad accident, but when the subscription list was passed around for him, the men naturally felt that however worthy the case might be they simply could not contribute, and so the second man got almost nothing, even though his condition might have been more pitiful than that of the first. All members of the Thomson-Houston Mutual Benefit Association who have shown a ten-cent per week interest in its maintenance are equally provided for, and only the man who has passed through a crisis knows how much better $6 a week is than nothing.

2. The method represents insurance at cost. The running expenses of the association are almost nothing, and all contributors may feel assured that each dime they pay will be given out to some one in need.

3. The growth of true democracy is fostered. In the matter of membership it is something to know that all are on a level. Among people of many nationalities, engaged in varying daily duties, the sense of affiliation has a moral value and may serve to relieve misunderstandings. An association of over forty sections, with a membership of thousands, gives a feeling of "getting together" to some purpose.

4. As an experiment in government, the organization has been of especial value. By giving him some office, a man may be led to look at life from a new angle, and by being identified with a large institution, of which he is an acting unit, the idea of real democracy and the power of union in service are exemplified. Not only in direct results is there mutual benefit, but also in making acquaintances and as a lesson in self-help, the idea will have a useful and widening application.

To provide a method of extending financial assistance to members who are temporarily in need of money, the mutual benefit association founded a loan fund. The working method is simplicity itself. A sufficient sum was secured by means of entertainments or otherwise, the money being placed in the hands of a loan committee which receives applications for assistance and investigates each case. The present plan is to loan not more than $25 at one time, repayment being made weekly at the rate of 10 per cent of the amount secured, this sum to be deducted from the wages or salary of the borrower each week until the principal is paid. There is no publicity in case of a refusal to lend, nor any dunning of a party who has been accommodated. He simply glances at his pay-check to see that the proper deduction has been made, and his fellow workmen need not even know that such a transaction is under way. No interest is charged for the accommodation. A second or third loan may be secured by the same person in case of real need, but only after prior loans have been paid. It is probable that this method of helping the unfortunate will find wider application in the factory, with larger funds available for this purpose. It will be seen that a few hundred dollars placed at the disposal of a representative committee may be manipulated in a way to enable it to pay an endless chain of debts.

FILING ARTICLES AND DATA*

A SCRAP-BOOK FILE PERMITTING BOTH SIDES OF CLIPPINGS TO BE READ

BY F. C. EVERITT†

Every engineer, shop superintendent and foreman recognizes the value of collecting magazine articles and data pertaining to the various branches of his particular line of work. After spending years in gathering information of this sort, the collector is usually confronted with the somewhat tedious task of eliminating the useless parts of the collection and filing the remainder or binding it in book form. Flexible leather covers are available for this purpose, but the home-made scrap-book described in the present article has been found to be particularly satisfactory. The preservation of articles and data in this way is a matter that no technical man—be he engineer, superintendent, mechanic, or apprentice—can afford to neglect, and the earlier in his career that he starts his collection, the more valuable it will be in years to come.

While the idea may seem simple enough at the start, the engineer or apprentice will find that as he becomes more experienced in his work he will need to give more attention to the subject of clipping and filing information that appears in the technical journals to which he subscribes. This will include a careful study of all articles, the selection of those which are most likely to be of value in years to come, and finally the classification and indexing of these articles in such a way that the information can be readily located. Experience in this work will make it continually easier to handle, so that a great deal of time will not be required for this purpose. Different methods of filing and binding such collections have been referred to in previous articles in MACHINERY. The subject is one that has been given considerable thought and various methods have been developed, all of which have their good points.

Fig. 1. Scrap-books for filing Articles and Data

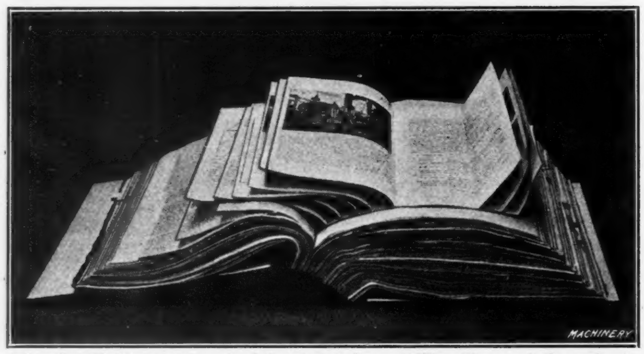

Fig. 2. Eighteen Page Article mounted on Filler Sheet of Scrap-book

The writer has been collecting data along these lines for a period of ten years and his method of preserving the material consists of pasting it in a loose-leaf scrap-book. The idea is quite general that scrap-books are unsatisfactory because it is necessary to have two copies of each article in order to paste them into the book without spoiling one side of each sheet. The method which is to be described in this article entirely avoids this difficulty and will probably be of interest to many readers.

Fig. 1 shows three bound volumes of articles and data. The large binder is 9 by 11 inches in size and is 3 inches thick when filled. "Filler sheets" made of paper of about the same thickness as ordinary letter paper are used to mount the articles on. These filler sheets are held together in the binder with an ordinary shoestring, and cardboard separators about 1/32 inch thick are used to prevent any tendency to bulge.

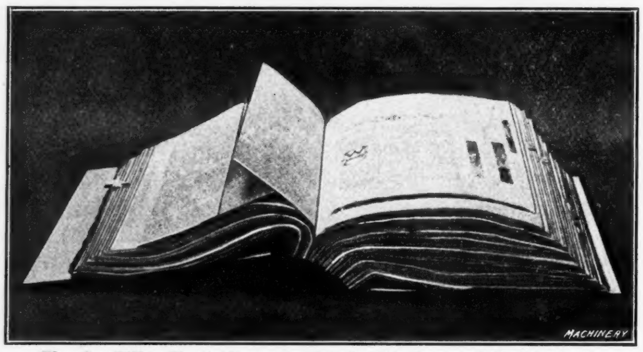

Fig. 3. Filler Sheet shown in Fig. 2 with Leaves folded back to close Scrap-book

These separators are used at intervals of five sheets. The articles are pasted on the filler sheets along the margin so that any sheet may be folded back to make both sides visible. This arrangement makes a neat and handy book; it opens readily and is practically as satisfactory as a flexible leather bound handbook. The small volumes shown in Fig. 1 contain data and articles that are referred to quite frequently. These books are 6 by 9 inches and serve practically the same purpose as a handbook. They are made up according to the method previously described.

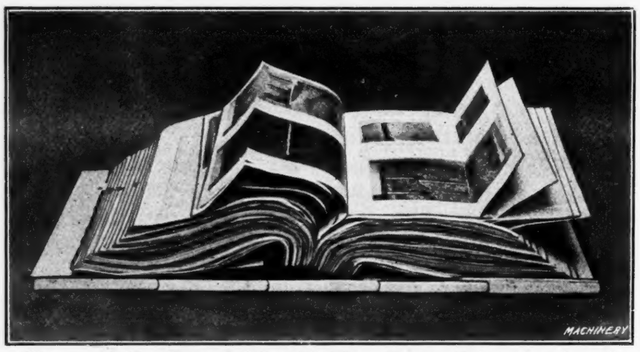

Fig. 4. Sixteen Page Article with Those Leaves that project beyond Filler Sheet turned back

It has been previously stated that the objection to scrap-books is largely due to the fact that two copies of each article are required if they are mounted in the usual manner. Reference to Fig. 2 will show that this objection is entirely overcome by the present method. This illustration shows a filler sheet on which an eighteen-page article—clipped from the *Engineering Magazine*—has been mounted. This article, folded ready for the book to be closed, is shown in Fig. 3; only one copy of the magazine was used. Fig. 4 shows a sixteen-page article cut from the *Foundry*. It will be seen that it is necessary to fold back some of the leaves before closing the book in order to prevent them from extending beyond the edge

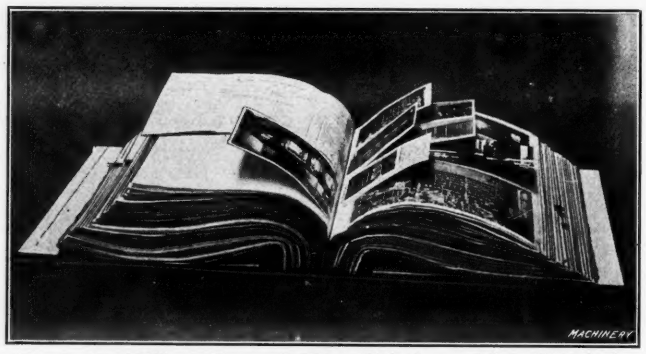

Fig. 5. Small Illustrations and "Shop Kinks" mounted in Scrap-book

* For further information on this subject see "Bollinckx's Scrap Book," August, 1910; "A Systematic Scrap Book," November, 1910, and January, 1911; "The Filing and Indexing of Engineering Data," March, 1911.

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of the filler sheet. Fig. 5 shows a filler sheet with several small illustrations, shop kinks and other clippings mounted on it.

The method of pasting the sheets in the book is important. When done in this way, there will be no stiffness, the page being practically as flexible as one without anything pasted on it. Both sides of the filler sheet can be used, it being possible to paste a second article of equal size on the opposite side of the sheet without materially affecting its flexibility. Successive pages of the article are pasted on the filler sheet beginning at the binding edge in all cases. Paste is applied to about ⅜ inch along the left-hand margin of the sheet, if it is to be pasted on the right-hand page of the scrap-book, or along the right-hand margin of the sheet if it is to be pasted on the left-hand page of the scrap-book. The general construction of the book is shown in Fig. 6, where *F* represents the filler sheets, *S* the separators, and *R* and *L* the covers. The notations in this illustration will make the construction readily understood.

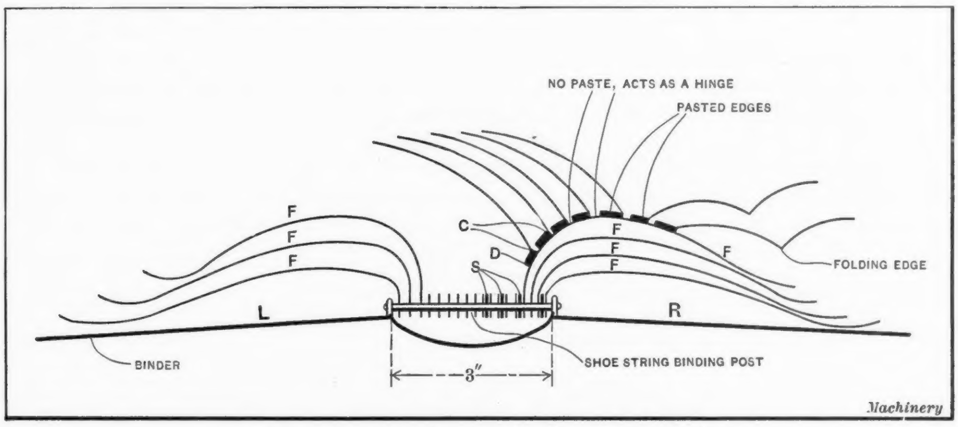

Fig. 6. Detail View of Construction of Scrap-book

The question of indexing is one that is likely to give considerable trouble until a satisfactory method has been worked out. The "subject method" will be found most satisfactory for this purpose. The following gives a brief description of the plan adopted. The original idea of starting this scrap-book was to make a factory reference book, but the idea was later extended to make its scope more general. Under the original plan, a departmental division was made and these divisions were given numbers as shown below.

General Office	No. 1
Purchasing Office	No. 2
Drafting Department	No. 3
The Plant	No. 4
General Cost Methods and Forms	No. 5
Foundry and Pattern Shop	No. 6
Machine Tools and Toolroom	No. 7
Stock Room Methods	No. 8
Non-Ferrous Metals and Methods	No. 9

(The first sheet in the book bears just such a list; but no further indexing is used.)

Each division was sub-divided into as many sections as required. For instance, the foundry and pattern shop are two departments which are combined under one heading because of their close connection, but this name in itself suggests the first sub-division. Hence, under the sub-division "foundry" we have the following subjects to consider: Cupola practice; molding methods and machinery; flasks; sands; facings; core room methods and equipment; core sands, oils, etc.; cleaning shop methods and equipment, etc. Such a subject list can be gradually increased with the growth of the collection and further indexing for the benefit of the user will be unnecessary on account of his familiarity with the method of arrangement.

As the collection grows, the first book will probably become too small, in which case a second volume may be started by transferring half of the contents of the first volume to a second binder. Additional filler sheets are then provided to fill each of the binders to its full capacity. Where the collection has grown to a considerable size, each division may be kept in a separate binder, if such a method appears to be desirable. Such a plan can be adopted at any time where this method of binding is used. Reference to Fig. 2 will show that index tabs are provided on the margins of the sheets. These tabs are made of linen and are pasted to the filler sheets; they bear the title of the division which they mark in order to facilitate finding the desired place in the book.

Figs. 2, 3 and 4 show one article mounted on a filler sheet. In such cases, a symbol is used which indicates the number of leaves in the article. For instance, the article in Fig. 2 covers nine leaves (eighteen pages). The first leaf bears the title of the article and the symbol 1-9, the remaining sheets being 2-9, 3-9, 4-9, 5-9, etc. In the case of short articles it is frequently desirable to mount three or four such articles on a single filler sheet of the scrap-book. The different articles on a sheet are indexed by letters—as *a*, *b*, *c*—and the sheets of the different articles are indicated as follows:

$$\frac{a}{3}, \frac{2a}{3}, \frac{3a}{3}; \frac{b}{2}; \frac{2b}{2}; \frac{c}{4}, \frac{2c}{4}, \frac{3c}{4}, \frac{4c}{4}.$$

Little time is required to make these notations and in cases where the first article covers succeeding articles on the same filler sheet, the symbols will indicate this fact.

It will be well to mention that whenever an article is clipped from any publication, the writer always indicates the name of that publication on the sheets and the date of the issue in which the article was published. This, of course, is only necessary where the title printed on the sheets is trimmed off to make their size conform to the requirements of the scrap-book. As time goes on, certain articles which have been preserved in the collection will become obsolete and with the present method of preservation, such articles can be removed without damaging them or destroying the filler sheet. A fresh article can then be substituted in place of the one which was removed. The easiest way to do this is to cut the article out along the edge *C* of the sheet, as indicated in Fig. 6. The new article is then substituted by pasting it along the surface *DC*. This method of preserving data has been the means of supplying the writer with information of considerable value to him in his work. The method of binding is compact and as a result a volume can be taken to any part of the factory where it is required. The expense of providing filing cabinets or other equipment of a similar nature for preserving the data is entirely eliminated.

* * *

BLUE-BLACK FINISH ON SMALL STEEL PARTS

To obtain a blue-black finish on small steel parts, use a mixture of 16 parts, by weight, saltpeter, and 2 parts black oxide of manganese. This is heated to a temperature of 750 degrees F. and the objects are immersed in it. The finish is "built on" to the metal so that if the work is round, for example, the diameter is slightly increased. The oxide of manganese is deposited on the work and must, therefore, be frequently replenished in the mixture.

* * *

The northwestern part of Germany has a very large area covered with peat bogs, and efforts have been made both by the Government and private interests to make possible the utilization of the peat. Experimental power stations that have been built indicate that it is possible that these desolate regions will prove to contain some of the most valuable natural resources of the country. There is, in that part of the country, but little hydraulic power available, and steam power must, therefore, be resorted to for all industrial undertakings. Should it prove economical to burn peat in power stations located at convenient places in the peat bog district, it has been estimated that these peat bogs would be able to supply all the power needed in the northwestern section of Germany for two centuries.

STEAM POWER PLANT PIPING DETAILS—5*

PROVIDING FOR EXPANSION AND CONTRACTION STRAINS IN PIPING SYSTEMS

BY WILLIAM F. FISCHER†

Among the numerous problems that confront the designer of a system of steam piping for a modern power plant is that of satisfactorily taking care of the expansion and contraction of the pipes which occurs after the piping system is put into operation. When designing the piping system the designer should always keep in mind the necessity of providing for expansion and contraction strains, otherwise trouble is sure to result when the station is turned over to the operating force. In power plants using superheated steam at high pressure, the problem of properly providing for expansion and contraction strains throughout the system is one of the most important of all problems encountered in the design. Take, for example, a steam main 200 feet long, which is installed during the winter months when the temperature of the surrounding atmosphere is, say, 50 degrees Fahrenheit. After steam at 175 pounds gage pressure and 150 degrees superheat is turned into the piping system, the steam main will expand or increase in length approximately eight inches, an increase in length of approximately four inches in every hundred feet of pipe. This will serve to give the reader some idea of the necessity of providing flexible pipe connections between all boilers and prime movers in a modern steam power station. Expansion and contraction strains, unless properly cared for, will invariably cause leakage at the pipe joints, and around the valve seats by straining and distorting the valve body, and in many cases they have been known to cause rupture of the valves or fittings in the line, resulting in serious damage and loss of life. Most large manufacturers of valves and fittings have an inspection and testing department where all valves made by them are tested under hydraulic pressure for leakage through the seat rings and around the disks before the valves leave the factory. If a leaky valve is found it is sent back to the machine shop to be made tight before shipment. No amount of testing and inspection, however, will prevent a gate valve from leaking after it is coupled up in the pipe lines and subjected to the severe expansion and contraction strains encountered in poorly designed piping systems. A slight distortion of the valve body is sufficient to throw the valve seats out of alignment, and in this case, especially with the solid wedge type valves, the disks will not seat properly, and leakage is sure to result. In many cases the valve manufacturer is accused of turning out poor work in this respect, when the fault lies with the designer or erector of the piping system. A valve that cannot be closed steam tight is more or less of a nuisance around a power plant, and realizing this to be true the valve manufacturers have, during the past few years, added considerably more metal to their valve bodies, not for the purpose of holding the higher pressure but simply to guard against distortion of the valve bodies when subjected to expansion strains in the pipe line.

Leaky pipe joints are also a considerable source of annoyance and worry around a power station, not to mention the loss of time and the expense of repacking or repairing them. When making repairs or renewing gaskets in a steam main, it is frequently necessary to shut down part of the main and throw one or more steam driven units out of service. In some cases the engineer may repack a leaky joint, making it absolutely steam tight, only to find in a few days that it leaks as badly, if not worse, than it did before it was packed. In a case of this kind the trouble is undoubtedly caused by expansion or contraction strains in the piping system, and this condition should be relieved before spending both time and money in a useless effort to keep the joints tight. Vibration of a steam main may also cause the joints to leak by working the pipe threads loose, or by wearing the gaskets or loosening the bolts on a flanged joint. Spacing hangers too far apart is another cause of leaky joints. The weight of the pipe, fittings and valves imposes a strain on the joints sufficient to spring them slightly and cause leakage. Where a steam plant is operated during the day and shut down at night, or *vice versa*, the piping system is alternately heated and cooled each day, thus setting up expansion and contraction strains that are very apt to cause the pipe joints to leak. When a steam plant is operated continuously, as in some of the larger stations, there is less danger of leakage from this source.

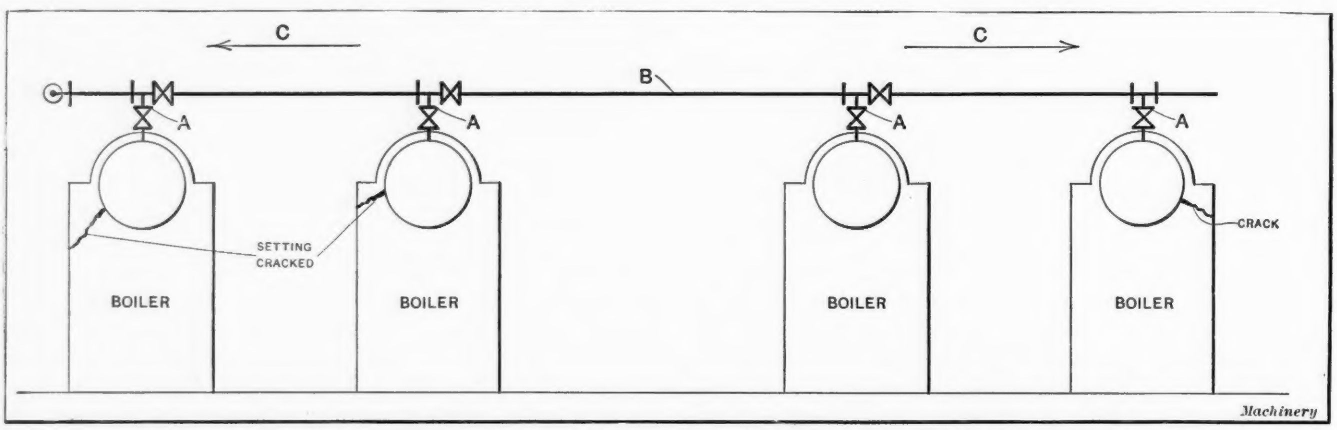

Fig. 38. Example of Cracked Boiler Setting caused by Failure to provide for Expansion and Contraction Strains in Piping

In visiting small power stations in which the piping systems are improperly designed and no provision is made for expansion and contraction strains, one frequently sees boiler setting that is badly cracked. This may be caused by providing rigid piping connections between the boilers and the main steam header; Fig. 38 illustrates an example of this kind. In this case, the main steam header was placed directly above the boiler nozzles, as shown, with a gate valve between each boiler and the header. As a result of this rigid piping connection the expansion of the main header *B*, tending to lengthen it in the direction of the arrows *C*, shifted the end boiler drums sufficiently to cause the brick setting to crack as indicated.

Estimating Expansion and Contraction of Steam Mains

All metals expand when heated and contract when cooled, the actual amount of expansion or contraction depending upon the metal and the number of degrees that its temperature is raised or lowered. The amount that a piece of metal expands in proportion to its length per degree rise in temperature is known as the coefficient of expansion. The coefficients of expansion for different metals have been quite accurately determined by different experimenters and the results may be found in almost any engineer's hand-book. The coefficients as given in Table I are used by the writer when calculating expansion or contraction in steam mains and will be found sufficiently accurate for all practical purposes of design.

When a steam pipe is heated it expands or increases in

* Continued from May number of MACHINERY.

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length, and when it is cooled it contracts or decreases in length. The coefficient C given in the second column of the table is the expansion or contraction per unit of length per degree Fahrenheit rise or fall in temperature of the piping material. To find the amount of expansion or contraction in a steam main per unit of length, multiply the coefficient, as given in the table, by the number of degrees Fahrenheit that the pipe is heated or cooled. To find the amount of expansion or contraction in a steam pipe of a given length in feet, multiply the length in feet by 12 to reduce to inches; then

TABLE I. COEFFICIENTS OF LINEAR EXPANSION FOR VARIOUS METALS TEMPERATURE RANGE 32 TO 600 DEGREES F. —AVERAGE VALUES

Piping Material	Coefficient of Expansion C	Piping Material	Coefficient of Expansion C
Cast iron.........	0.000006	Wrought iron.....	0.000007
Untempered steel.	0.000006	Copper...........	0.000009
Tempered steel...	0.000007	Brass.............	0.0000095
Steel castings.....	0.000007	....	....

Machinery

multiply the length in inches by the number of degrees Fahrenheit that the pipe is heated or cooled, and multiply the result by the coefficient in the table. The final result will be the total amount of expansion or contraction of the pipe in inches.

Example:—A steam pipe of wrought iron is installed in a room in which the temperature of the air is 60 degrees Fahrenheit. After the pipe is erected it is found to be 100 feet long. How much will the pipe increase in length when steam is turned on, heating the piping material to 360 degrees Fahrenheit?

$100 \times 12 = 1200$ inches, length of the pipe as installed at 60 degrees Fahrenheit.

Rise in temperature of pipe when heated $= 360 - 60 =$ 300 degrees Fahrenheit.

Coefficient of expansion for wrought iron $= 0.000007$.

Then multiplying, we get $1200 \times 300 \times 0.000007 = 2.52$ or $2\frac{1}{2}$ inches, increase in length due to expansion when heated. If the steam is shut off and the pipe allowed to cool again to 60 degrees Fahrenheit, it will assume its original length, *i. e.*, 100 feet, due to contraction of the piping material.

The expansion or contraction of a steam main may be calculated by the aid of the following formula:

$$e = LCT \qquad (1)$$

where e = Amount of expansion or contraction in inches due to heating or cooling of piping material.

L = Original length of pipe, in inches, before being heated or cooled.

T = Number of degrees Fahrenheit pipe is heated or cooled.

C = Coefficient of linear expansion. (Table I.)

As a practical example showing the use of the formula, assume the following: Fig. 39 illustrates a 6-inch wrought iron steam main which was erected while the temperature of the room was, say, 60 degrees Fahrenheit. Assume the pipe to be anchored only at point A, and no expansion bend provided to take up or relieve the expansion. After erection, saturated steam at 200 pounds per square inch is turned into the piping system and it is desired to compute the expansion of the 6-inch main at the points B, C and D.

From Formula (1) we have $e = LCT$:

Between points A and B, $L = 200 \times 12 = 2400$ inches.

Between points B and C, $L = 60 \times 12 = 720$ inches.

Between points C and D, $L = 45 \times 12 = 540$ inches.

In order to compute the difference in temperature, T, of the pipe when cold and when heated we must assume the pipe to be heated to the same temperature as the steam which it conveys. Then from our steam tables we find the temperature of saturated steam at 200 pounds gage pressure ($200 + 15 = 215$ pounds absolute) to be 388 degrees Fahrenheit. Subtracting from this the original temperature of the pipe (the temperature when cold) we have $388 - 60 = 328$ degrees rise in temperature $= T$. Substituting the above values in Formula (1) we find the expansion between points A and B to be $e = 2400 \times 0.000007 \times 328 = 5\frac{1}{2}$ inches, making $L_1 = 200$ feet $5\frac{1}{2}$ inches. Between points B and C, $e = 720 \times 0.000007 \times 328 = 1.65 = 1\frac{5}{8}$ inch, making $L_2 = 60$ feet $1\frac{5}{8}$ inch. Between points C and D, $e = 540 \times 0.000007 \times 328 = 1.24$ inch or $1\frac{1}{4}$ inch, making $L_3 = 45$ feet $1\frac{1}{4}$ inch. (See Fig. 39.)

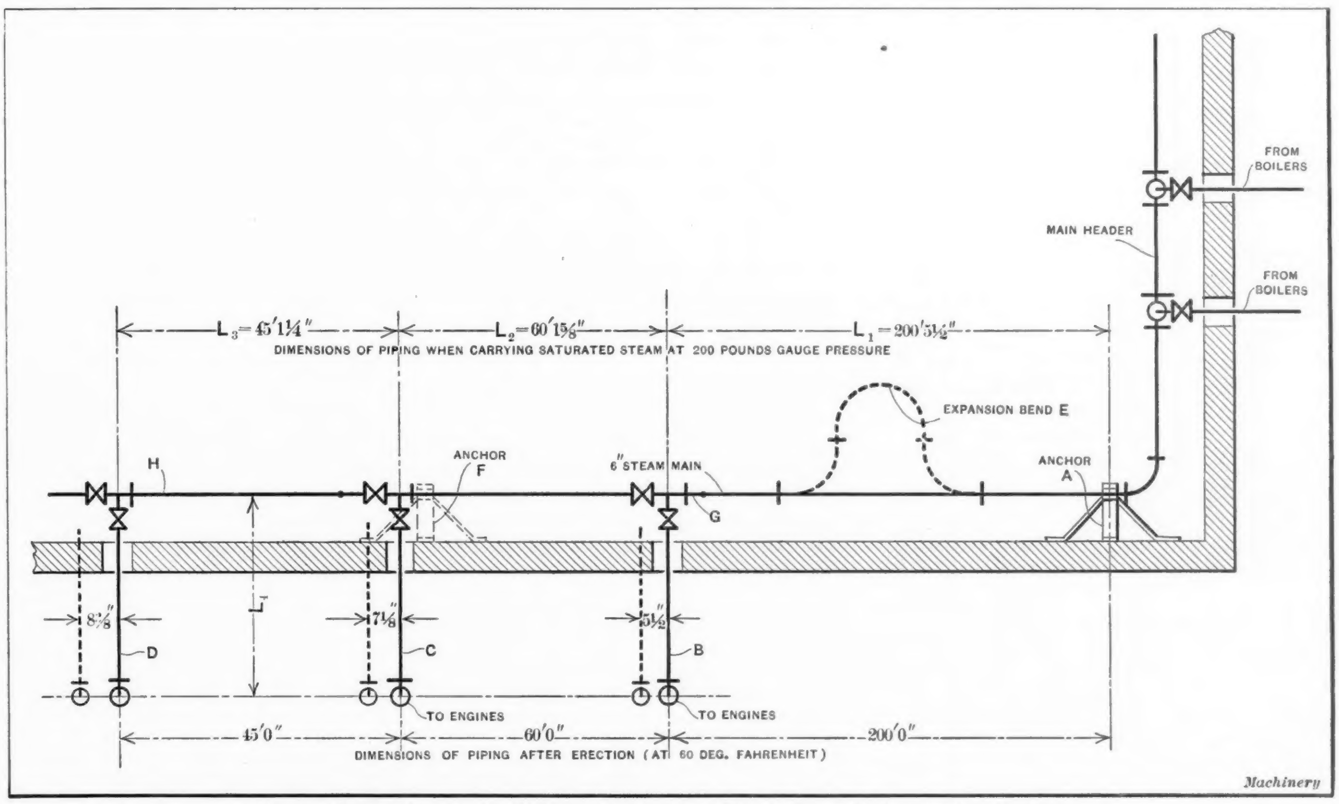

Fig. 39. Illustration showing Difference in Length of Pipe before and after turning in Steam

In looking over Fig. 39 we find that the expansion in the 6-inch main has the following effect on branch pipes B, C and D: Branch pipe B is moved $5\frac{1}{2}$ inches out of line; branch pipe C is moved $5\frac{1}{2} + 1\frac{5}{8} = 7\frac{1}{8}$ inches out of line; and branch pipe D is moved $5\frac{1}{2} + 1\frac{5}{8} + 1\frac{1}{4} = 8\frac{3}{8}$ inches out of line as shown. If distance L_4 is short, thus making a fairly rigid piping connection between the 6-inch main header and the engines, the reader can readily realize the enormous strain that is thrown on the pipe joints in branches B, C and

D, as no provision is made to take up the irresistable expansion strains in the 6-inch header. Either one of three things must happen. The branch pipes *B*, *C* and *D* will move out of line, or "spring," as shown; the 6-inch main header will spring or bow out of shape; or the pipe joints will fail. The force of expansion and contraction, and the strains set up in the piping system will be discussed later.

In a case of this kind it would be good practice to install anchors at two points *A* and *F* and provide an expansion bend

TABLE II. EXPANSION OF WROUGHT IRON STEAM PIPES CARRYING SATURATED STEAM AT VARIOUS PRESSURES

Initial Temperature of Pipe in Degrees Fahrenheit	Gage Pressure, Pounds per Square Inch									
	Atmospheric Pressure = 0 Gage	5	50	75	100	125	150	175	200	250
	Temperature of Steam in Degrees Fahrenheit									
	212	228	298	320	338	353	366	377	388	406
	Expansion of Pipe in Inches per Foot of Length									
30	0.0153	0 0166	0 0225	0.0244	0.0259	0.0271	0.0282	0.0292	0.0301	0.0316
35	0.0149	0.0162	0 0221	0.0239	0.0255	0.0267	0.0278	0.0287	0.0297	0.0312
40	0.0145	0.0158	0.0217	0.0235	0.0251	0.0263	0.0274	0.0283	0.0292	0.0307
45	0.0141	0.0154	0.0213	0.0231	0.0246	0.0259	0.0270	0.0279	0.0288	0.0303
50	0.0136	0.0149	0.0208	0.0227	0.0242	0.0255	0.0265	0.0275	0.0284	0.0299
55	0.0132	0.0145	0.0204	0.0223	0.0238	0.0251	0.0261	0.0271	0.0280	0.0295
60	0.0128	0.0141	0.0200	0.0219	0.0234	0.0246	0.0257	0.0266	0.0275	0.0291
65	0.0124	0.0137	0.0196	0.0214	0.0229	0.0242	0.0253	0.0262	0.0271	0.0287
70	0.0119	0.0133	0.0192	0.0210	0.0225	0.0238	0.0249	0.0257	0 0267	0.0282
75	0.0115	0.0129	0.0188	0.0206	0.0221	0.0234	0.0244	0.0253	0 0263	0.0278
80	0.0111	0.0124	0.0183	0.0202	0.0217	0.0229	0.0240	0.0249	0.0259	0.0274
85	0.0107	0.0120	0.0179	0.0198	0.0213	0.0225	0.0236	0.0245	0.0255	0.0270
90	0.0103	0.0116	0.0175	0.0193	0.0208	0.0221	0.0232	0.0241	0.0250	0.0266
100	0.0094	0.0108	0.0166	0.0189	0.0200	0.0213	0.0223	0.0237	0.0242	0.0257

Machinery

For cast-iron pipe multiply the above values by 0.91. For brass pipe multiply the above values by 1.454.

E (shown dotted) placed somewhere in the line between the anchors to take up or relieve the expansion. As the expansion between points *A* and *C*, as figured above, is approximately 7 inches, the expansion bend *E* will close up or be drawn together at the ends approximately 7 inches, due to the expansion in the line between the two anchors. With this arrangement, branch pipe *C* remains practically stationary, and branches *B* and *D* are each moved out of line not over 1½ inch, due to the expansion in the 6-inch main, as against 5½ and 8⅜ inches, respectively, in the previous case without the expansion bend. This example may be applied to almost any condition and arrangement of piping, and by studying the conditions as described above, the reader will be able to place his expansion bends and anchors where they will do the most good. The expansion strains in the 6-inch main could be entirely relieved by placing additional anchors at points *G* and *H* and installing expansion bends in the main header between branches *B* and *C*, and *C* and *D*. This is not necessary, however, unless distance L_4 is very short, in which case it might be necessary to do so in order to prevent strains on the pipe joints.

TABLE III. EXPANSION OF STEEL STEAM PIPES CARRYING SATURATED STEAM AT VARIOUS PRESSURES

Initial Temperature of Pipe in Degrees Fahrenheit	Gage Pressure, Pounds per Square Inch									
	Atmospheric Pressure = 0 Gage	5	50	75	100	125	150	175	200	250
	Temperature of Steam in Degrees Fahrenheit									
	212	228	298	320	358	353	366	377	388	406
	Expansion of Pipe in Inches per Foot of Length									
30	0.0131	0.0143	0.0193	0.0209	0.0222	0.0233	0.0242	0.0250	0.0258	0.0221
35	0.0128	0.0139	0.0189	0.0205	0.0218	0.0229	0.0238	0.0246	0.0254	0.0267
40	0.0124	0.0135	0.0186	0.0201	0.0214	0.0225	0.0235	0.0243	0.0250	0.0263
45	0.0120	0.0132	0.0182	0.0198	0.0211	0.0222	0.0231	0.0239	0.0247	0.0260
50	0.0117	0.0128	0.0178	0.0194	0.0207	0.0218	0.0227	0.0235	0.0243	0.0256
55	0.0113	0.0124	0.0175	0.0191	0.0204	0.0214	0.0224	0.0232	0.0240	0.0252
60	0.0109	0.0121	0.0171	0.0187	0.0200	0.0211	0.0220	0.0228	0.0236	0.0249
65	0.0106	0.0117	0.0168	0.0183	0.0196	0.0207	0.0217	0.0225	0.0232	0.0245
70	0.0102	0.0114	0.0164	0.0180	0.0193	0.0204	0.0213	0 0221	0.0229	0.0242
75	0.0098	0.0110	0.0160	0.0176	0.0189	0.0200	0.0209	0.0217	0.0225	0.0238
80	0.0095	0.0106	0.0157	0.0173	0.0186	0.0196	0.0206	0.0214	0.0222	0.0235
85	0.0091	0.0103	0.0153	0.0169	0.0182	0.0193	0.0202	0.0210	0.0218	0.0231
90	0.0088	0.0099	0.0149	0.0165	0.0178	0.0189	0.0198	0.0207	0.0214	0.0228
100	0.0081	0.0092	0.0142	0.0162	0.0171	0.0182	0.0195	0.0199	0.0211	0.0220

Machinery

Expansion of Steam Mains carrying Superheated Steam

When figuring the expansion of a steam main carrying superheated steam the designer should not forget to add the temperature due to superheating. In the previous example the temperature of saturated steam at 200 pounds gage pressure was found to be 388 degrees Fahrenheit. If, instead of carrying saturated steam at 200 pounds gage pressure, this steam main was carrying superheated steam at 200 pounds gage pressure, superheated 100 degrees, the final temperature of the steam would then be 100 degrees higher due to the superheating, and the final temperature in this case would be 388 + 100 = 488 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe, in order to find the value of *T*, we would have 488 — 60 = 428 degrees rise in temperature which is the value to use in Formula (1) when figuring the expansion of the pipe for the preceding conditions. Tables of both saturated and superheated steam are given in the Marks & Davis steam tables, and the final temperatures may be read directly in either case. If, however, the reader possesses a table giving temperatures of saturated steam only, he may obtain from this table the final temperature of saturated steam at the same pressure as the superheated steam, and then add the number of degrees of superheat as described above. Superheating the steam as it leaves the boiler does not increase its pressure.

Tables for Estimating Expansion of Steam Pipes

Realizing the necessity of simplifying engineering calculations as much as possible, and in this case in order to save the time required to refer to steam tables, etc., the writer has prepared Tables II and III for use in calculating the linear expansion of wrought iron and steel steam pipes. A study of the tables and their use will prove a time saver in work of this kind. The coefficients of expansion given in Table I are average values, accurate enough for all practical purposes. Metals do not expand or contract uniformly throughout all ranges of temperature, but the writer has not taken this into account when preparing the tables. For example, at temperatures ranging from 32 to 100 degrees Fahrenheit, the coefficient of expansion for wrought iron pipe is approximately 0.0000065, increasing to approximately 0.000008 at 500 degrees Fahrenheit. Steam pipes, as used in modern practice, are either made of wrought iron or mild steel. The writer has therefore prepared two separate tables—Table II for wrought iron pipe and Table III for steel pipe.

These tables are to be used for saturated steam only. The steam pressures as given in the upper line of the tables are gage pressures, or the pressure as recorded on a steam gage. At atmospheric pressure (approximately 15 pounds

absolute) the steam gage would record no pressure, and the pointer would stand at zero on the dial. On the second line of the table is given the temperature of the steam, in degrees Fahrenheit, corresponding to the gage pressure in pounds per square inch, and below this line is given the expansion, in decimals of an inch per lineal foot of pipe. In the first column of the tables is given the initial temperature of the pipe in degrees Fahrenheit. To find the expansion in inches of a steam pipe of a given length in feet, it is necessary to know the approximate initial temperature of the pipe, or the temperature before steam is turned into it, and the temperature of the steam which the pipe is to convey. Multiplying the constants in the tables by the length of pipe in feet will give the total amount of expansion of the pipe in inches.

Example:—A wrought iron pipe 210 feet long, installed at a temperature of 50 degrees Fahrenheit, is to convey saturated steam at 150 pounds gage pressure. How many inches will the pipe expand when steam is turned into it? In the first column of Table II, on the fifth line down, will be found 50 degrees, the initial temperature of the pipe. In the eighth column, headed 150 pounds pressure, opposite 50 in the first column, will be found 0.0265, which is the expansion in decimals of an inch per foot of length. Multiplying this constant by 210, the length of pipe in feet, we get $0.0265 \times 210 = 5.57$ inches, or approximately $5\frac{9}{16}$ inches as the elongation of the pipe due to expansion.

Cast iron or brass pipe is seldom, if ever, used for steam mains in modern steam power plant work. For all practical purposes the cast iron or brass fittings in a steam main may be assumed to expand the same as the pipe. If it is desired to obtain constants similar to those in Tables II and III for use in figuring the expansion of cast iron or brass pipe per foot of length, multiply the constants given in Table II by 0.91 for cast iron pipe and by 1.454 for brass pipe. For example, if in the previous instance the pipe was of cast iron, instead of wrought iron, the constant 0.0265 would have to be reduced to $0.0265 \times 0.91 = 0.0241$, the expansion in decimals of an inch per foot of length, which, multiplied by 210, the length of pipe in feet, gives $0.0241 \times 210 = 5.06$ or approximately $5\frac{1}{16}$ inches. If the pipe was of brass instead of wrought iron, the constant 0.0265 would be increased to $0.0265 \times 1.454 = 0.0385$, which is the expansion in decimals of an inch per foot of length. This value multiplied by the length of the pipe in feet gives $0.0385 \times 210 = 8.09$ or approximately $8\frac{1}{16}$ inches. The constants given in the second and third columns of the tables will be found useful in calculating the expansion in atmospheric exhaust and low pressure heating mains. The tables do not apply to vacuum exhaust mains—a subject which will be treated separately in a later section of this article.

The Force of Expansion and Contraction

The necessity of providing flexible piping connections for properly anchoring steam mains, and of installing expansion bends wherever necessary will be better understood when we consider the practically irresistible forces that are set up in the piping material as heat is supplied to the walls of the pipe. We can calculate very closely the thrust exerted by an expanding steam pipe by the aid of the three following formulas:

Formula (1) is used for figuring expansion and contraction, and Formulas 2 and 3 are used in finding the elongation of a bar of metal due to a given external force such as a weight suspended from the end of the bar tending to stretch it. These formulas are as follows:

$$e = LCT \qquad (1)$$

$$e_1 = \frac{PL}{AE} \qquad (2)$$

$$P = \frac{e_1 AE}{L} \qquad (3)$$

The notation in Formlua (1) is the same as that used in the previous case for expansion due to heat. The notation for Formulas 2 and 3 is as follows:

e_1 = Total elongation of body in inches;
A = Cross sectional area of body in inches;
P = Total stress on body in pounds;
L = Original length of body in inches;
E = Coefficient of elasticity of metal composing body.
For wrought iron $E = 25{,}000{,}000$.
For steel $E = 30{,}000{,}000$.
For cast iron $E = 15{,}000{,}000$.

In Formulas 2 and 3, e_1 is equivalent to e in Formula 1, with the exception that the elongation e in Formula 1 is caused by an internal force due to heating the piping material, and the elongation e_1 in Formulas 2 and 3 is caused by an external force, such as a weight or pull. If we substitute e in Formula 1 for e_1 in Formula 3, we get:

$$P = \frac{eAE}{L} \qquad (4)$$

By substituting for e, its equivalent LCT (see Formula 1) we get:

$$P = \frac{LCTAE}{L} \qquad (5)$$

Cancelling L we have:

$$P = CTAE \qquad (6)$$

where

P = Magnitude of thrust in pounds exerted by the pipe when expanding, or the pull exerted when contracting.
C = Coefficient of linear expansion (see Table I).
E = Coefficient of elasticity of piping material.
A = Area of metal in a cross section of the pipe or body, in square inches.
T = Difference in degrees Fahrenheit of temperature between the initial temperature of the pipe, or body, and its temperature after being heated or cooled.

From the above formulas we find that the length L has been cancelled, and is not required in the following examples. Thus, Formula (6) should give us the magnitude of the thrust exerted by the pipe, regardless of its length, providing that it is prevented from expanding freely or springing sideways. This formula should be used for approximate results only, and within given temperature limits only, as a body when heated beyond a certain temperature loses a large percentage of its strength. The formula may be safely used for steam pipes heated to 600 degrees or more, and these high temperatures are seldom reached in ordinary steam power plant work. As an example showing the application of Formula (6), assume that we have a 12-inch extra heavy steel steam main braced along its entire length to prevent it springing sideways, and firmly blocked at each end to resist linear expansion. The original or initial temperature of the pipe when installed is 50 degrees Fahrenheit. If steam at 210 pounds gage pressure ($210 + 15 = 225$ pounds absolute) superheated 100 degrees, is turned into the main after erection, what will be the thrust exerted by the pipe due to expansion? From Formula (6) we have $P = CTAE$. C for mild steel $= 0.000006$ (see Table I). The temperature of saturated steam at 210 pounds gage pressure (225 pounds absolute) is found from the steam tables, to be 392 degrees Fahrenheit. Adding 100 degrees superheat, we have $392 + 100 = 492$ degrees Fahrenheit as the temperature of the superheated steam at the above pressure, superheated 100 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe, we get $492 - 50 = 442$ degrees Fahrenheit for the value of T in Formula (6). From a table of properties of standard and extra heavy steam pipes, as given in most pipe manufacturers' catalogues (see Table IV) we find the area of metal in a cross-section of 12-inch extra heavy pipe, to be 19.25 square inches, which is the value of A in Formula (6). E for steel pipe, as previously mentioned, equals 30,000,000. Substituting the above values in Formula (6) we have: $P = 0.000006 \times 442 \times 19.25 \times 30{,}000{,}000 = 1{,}531{,}530$ pounds as the thrust exerted by the 12-inch pipe, due to expansion. This divided by the area of metal in a cross-section of the pipe, in square inches, gives $1{,}531{,}530 \div 19.25 = 80{,}000$ pounds per square inch as the compression of the piping material, sufficient to cause rupture.

If, in the previous example, the pipe was allowed to expand freely when heated and then clamped tightly at each end to prevent it from contracting or returning again to its original length as it cooled down, the pipe material would be subjected to a tensile strain of 1,531,530 pounds or 80,000

pounds per square inch. This would be figured in exactly the same way as the previous examples, the only difference being that in the previous case the piping material is in compression due to expansion, and in this case it is in tension due to contraction. If, however, the pipe was permitted to expand and contract freely, no external resistance being offered, the above conditions would not hold good. External strains due to expansion and contraction are set up in the piping material only when the piping is rigidly connected, thus offering more or less resistance to the movement of the pipes, or the lengthening or shortening of the pipes as they expand and contract. The above examples serve to give some idea of the enormous strains thrown on the pipe, joints, valves and fittings in a steam main where no provision is made to take up or relieve the expansion and contraction. If the line is anchored improperly, either the anchors will give, or the pipe will spring sideways, thus straining the valves, fittings and pipe joints in the line, sufficiently in many cases, to cause excessive leakage, crack the flanges, or strain the valve bodies and distort the valve seats, causing leakage past the gate or disk.

In building a brick wall where a steam pipe passes through the wall, the bricklayers occasionally build the pipe in rigidly, thus making no allowance for expansion or contraction. The writer has seen cases where steam pipes built into a 12-inch brick wall in this manner have caused the wall to crack and bulge very badly. Where a steam pipe passes through a wall or floor, a sleeve or pipe thimble as they are called, should be built into the wall and should be large enough in diameter to permit drawing the pipe, flanges and all, through the thimble in case it becomes necessary at any time to remove a section of the pipe.

Fig. 40 will serve to illustrate a very rigid piping connection between duplicate steam mains, and the following example will give an idea of the severe strains the piping is subjected to when one main is shut down and the other main is kept alive to supply the engines. As an example, suppose two 8-inch wrought iron steam mains A and C (Fig. 40), are tied together by branch mains E and F through valves B and D, as shown in the end view. Ordinarily steam is kept on both mains, in which case expansion and contraction is nearly uniform in each main. In case of an accident occurring to either main it would then be shut down, and the other main kept in service while making repairs to the disabled section of the piping system. Assume for example that both mains, A and C (Fig. 40), were installed at a temperature of 60 degrees Fahrenheit and dimensions H and G at this temperature were found to be 90 feet. If, after erection, saturated steam at 190 pounds gage pressure ($190 + 15 = 205$ pounds absolute) was turned into steam main A only, valves D being closed, and steam main C being cold (60 degrees F.) as no steam is admitted to same, what effect would this have on the piping system?

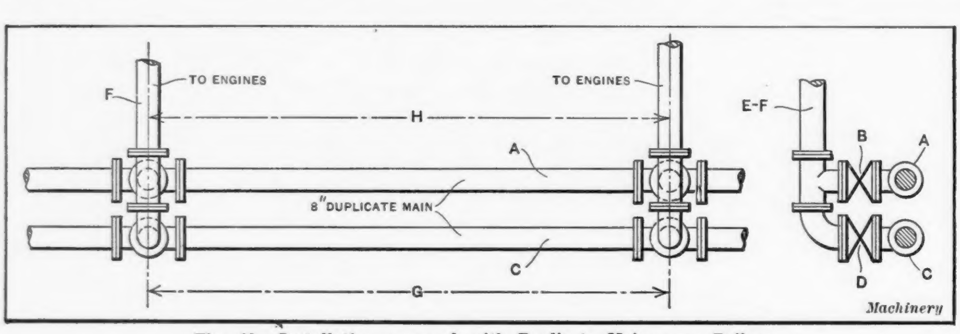

Fig. 40. Installation arranged with Duplicate Mains over Boilers

First let us find the elongation of steam main A between points E and F due to expansion in that section of the piping system. From Formula 1 we have: $e = LCT$ and by the above conditions we have $L = 90$ feet $= 90 \times 12 = 1080$ inches, and the coefficient of expansion $C = 0.000007$ for wrought iron (See Table I). In order to compute the rise in temperature T, we find by aid of the steam tables that the temperature of saturated steam at 190 pounds gage pressure, or 205 pounds absolute pressure, equals 384 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe (60 degrees F.) we have: $384 - 60 = 324$ degrees, equals temperature rise T.

Substituting these values in Formula 1, we have: $e = 1080 \times 0.000007 \times 324 = 2.45$ inches or $2\frac{1}{2}$ inches approximately, the elongation of steam main A. Adding the original length (dimension H) we have 90 feet $2\frac{1}{2}$ inches between points E and F if steam main A was free to expand. Dimension G, steam main C, is 90 feet 0 inches, however, as the pipe has not been heated and in order that steam main A be allowed to expand freely it would be necessary to lengthen steam main C $2\frac{1}{2}$ inches. Steam main C and the rigid piping connections at E and F would quite naturally resist the expansion or elongation of main A, thus throwing severe strains on the pipe joints and the valves B and D.

TABLE IV. AREA OF METAL IN STEAM PIPES*

Size of Pipe, Inches	Area of Metal in a Cross Section of Pipe in Square Inches = A			Size of Pipe, Inches	Area of Metal in a Cross Section of Pipe in Square Inches = A		
	Standard Pipe	Extra Heavy Pipe	Double Extra Heavy Pipe		Standard Pipe	Extra Heavy Pipe	Double Extra Heavy Pipe
1	0.4939	0.6388	1.076	4½	3.688	5.180	9.569
1¼	0.6685	0.8815	1.534	5	4.300	6.112	11.340
1½	0.7995	1.068	1.885	6	5.581	8.405	15.640
2	1.075	1.477	2.656	7	6.926	11.190	18.560
2½	1.704	2.254	4.028	8	8.399	12.760	21.300
3	2.228	3.016	5.466	9	9.974	14.330	......
3½	2.680	3.678	6.721	10	11.91	16.100	......
4	3.174	4.407	8.101	12	14.58	19.25	......

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* Condensed from National Tube Co.'s Catalogue

From Formula 6 we have: $P = CTAE$. Assuming steam mains A and C to be of 8-inch standard weight wrought iron pipe, we find from Table IV the area of metal in a cross-section of the pipe to be 8.399 square inches $= A$.

C from Table I $= 0.000007$.

$T = 324$ degrees.

$E = 25{,}000{,}000$ for wrought iron.

Substituting these values in Formula 6 we have: $P = 0.000007 \times 324 \times 8.4 \times 25{,}000{,}000 = 476{,}280$ pounds, the thrust exerted by steam main A when expanding. This means that the total tensile strain on the metal of the 8-inch pipe C equals 476,280 pounds, and as the area of the metal in the pipe equals 8.4 square inches, the stress per square inch would be $476{,}280 \div 8.4 = 56{,}700$ pounds per square inch. If steam were turned into both mains and then one of them shut down and allowed to cool to its initial temperature (60 degrees F.) the result would be practically the same, due to the contraction of the pipe when cooling. It is doubtful if the above stresses would actually be encountered in a case of this kind in practice as the steam main A being in compression lengthwise would bow or spring out of shape sideways due to its length before any such stresses would be realized. The above examples give, however, a general idea of the stresses likely to be encountered in work of this kind. The above example does not take into account the tension on the metal of steam main A due to the steam pressure of 190 pounds per square inch acting against the ends of the pipe tending to stretch it. The internal area of an 8-inch standard weight steam pipe is approximately 50 square inches. Therefore $50 \times 190 = 9500$ pounds total, or $9500 \div 8.4 = 1131$ pounds per square inch tension on the metal of steam pipe A due to the steam pressure tending to stretch the pipe. As this stress is all resisted by the metal of pipe A it does not enter into the previous calculation.

Rigid piping connections between two steam mains, such as shown in Fig. 40 should never be employed. The writer assumed this condition merely to illustrate the above example.

THE VETTER STEEL TYPE MAKING MACHINE

A RECENT DEVELOPMENT IN MACHINERY FOR MAKING STEEL TYPE FOR TYPEWRITERS

BY CHESTER L. LUCAS*

Since the advent of the typewriter the problem of making steel type has been a very important one. Several different processes have been followed during the past thirty years, all of which are based on the principle of forcing the metal of the type blank into a hardened steel matrix. A general idea of typewriter type may be obtained from Fig. 1, which illustrates at *A* blanks from which the type are made, showing the slot by which the type is secured to the type bar; at *B* type just as it leaves the matrix, with the displaced metal left untrimmed; and at *C* completed type with this fin of extra metal sheared off. The primitive method of typewriter type-making was that of using a drop-hammer, mashing the blanks straight down into the matrices by a direct blow. Although the type blanks were prepared in different ways in order to make the metal flow more easily, this method was given up years ago as being impracticable because the surface of the type could not be readily brought up sharp.

Another of the earlier methods used by prominent type-

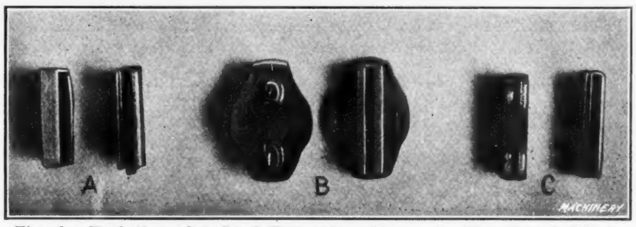

Fig. 1. Evolution of a Steel Typewriter Type. A, The Slotted Blank; B, The Kneaded Type; C, The Trimmed Type

writer manufacturers was the rolling process whereby the type blanks were mounted about the circumference of a large heavy roll indicated in the diagram at *A* in Fig. 2. This rolling method operated similarly to a printer's proving press, and as the matrices were clamped upon the bed of the apparatus the type blanks were forced into them when the roll was passed over the bed under pressure. Although this method is in use today in some shops, it has serious dis-

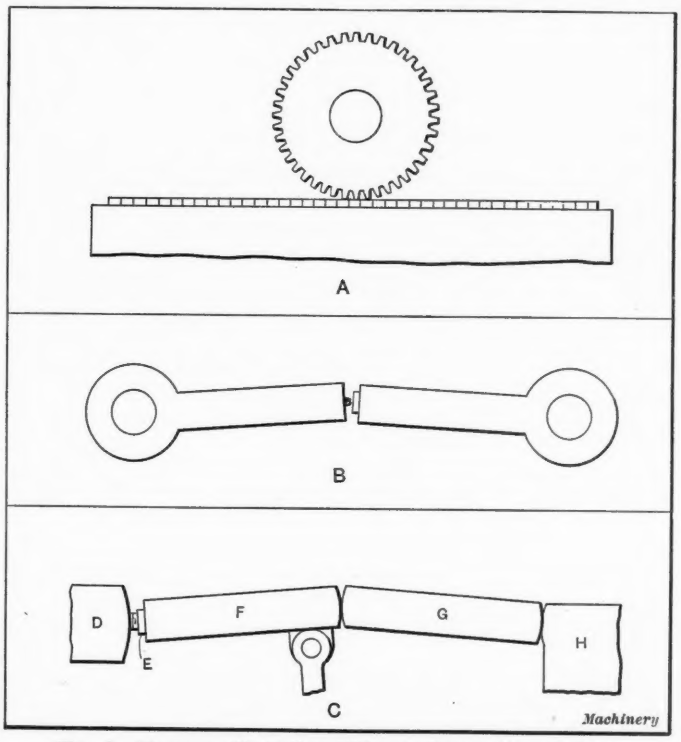

Fig. 2. Diagrams illustrating Different Type-making Methods

advantages, trouble frequently arising from the "creeping" of the metal in the type blanks. In addition, it is difficult to line the dies up properly for the work.

Until recently the most generally used machine for type-writer type-making was the Mallonee machine. This is a hand-operated machine which incorporates the kneading or knuckling movement which has been so successful in type-making. By referring to Fig. 2 at *B* the principle upon which the Mallonee machine operates will be seen. Two arms or levers are pivoted upon shafts at opposite ends of the machine,

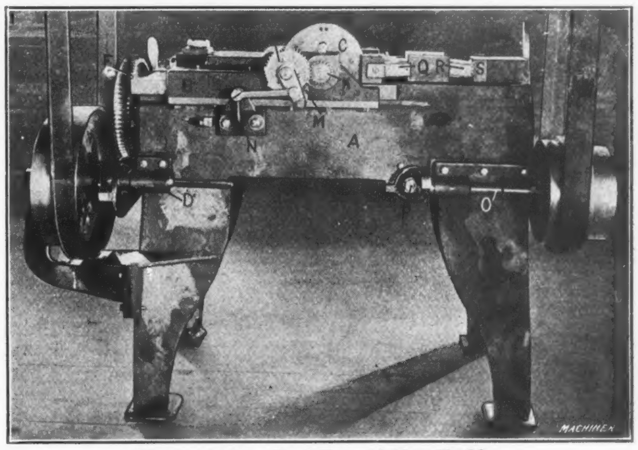

Fig. 3. Vetter Steel Type Making Machine

and in the end face of one of these arms the matrix is held, while in the corresponding end face of the other arm the blank is held. Now, by kneading these two arms of the machine together the metal of the type blank is caused to fill the impression in the matrix. The capacity of this machine is 1700 type per day. Good type is obtained from this style of machine, but its disadvantage lies in the fact that a great amount of friction is developed on account of the arms being

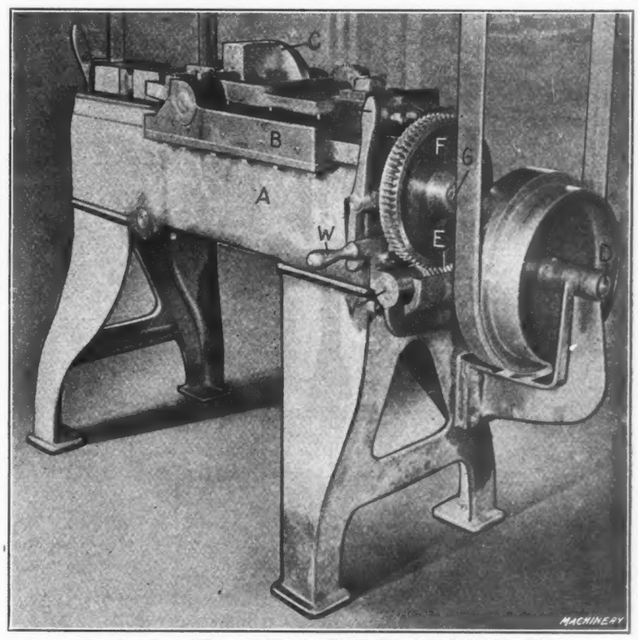

Fig. 4. Rear View of Vetter Steel Type Making Machine

under pressure while they are undergoing the kneading process; it will be seen that the friction in the arm bearings upon the shafts must be great. Also the fact that the machine is hand operated greatly limits the production.

The Vetter Machine

One of the latest and most improved of type-making machines and a machine which has been adopted in several of the leading typewriter factories is the Vetter machine illustrated in Figs. 3 and 4. This machine is the invention of R. C. Vetter, Syracuse, N. Y., and is made by the Acme Tool & Die Co., also of Syracuse. The machine embodies the kneading principle, but its chief advantages are that the frictional losses are largely overcome and in addition the machine is semi-automatic in its operation. The illustration at *C* in Fig. 2 shows the principle upon which the mechanism operates. The type blanks are held in a four-position turret,

* Associate Editor of MACHINERY.

a section of which is indicated at *D*. The matrix *E* is held in the end of arm *F* which is one of the kneading members. The other kneading member *G* bears against the frame of the machine at *H*. By reciprocating member *G*, arm *F* is caused to rock, thereby working the face of the matrix against the type blanks which are held in the turret. It will be observed that there are no shafts to cause friction, the entire kneading pressure being taken upon the carbon contact faces between the members *F* and *G* and *G* and *H*. This, in brief, explains the operating principle of the mechanism, but there are some interesting details of the machine which it will be profitable to consider.

Upon the top of frame *A* of the machine as illustrated in Figs. 3, 4 and 5, is mounted a carriage *B* which supports the turret *C*. The carriage and turret have a reciprocating movement, causing the carriage to make a stroke of 2½ inches and return every six seconds. The carriage is operated through power from the driving shaft *D* and thence to worm *E* and wormwheel *F*. Located within the machine on shaft *G*, upon which wormwheel *F* is located, is a barrel cam *H*, more clearly shown in the line illustration Fig. 5. The carriage is guided in its reciprocating movement by means of a stud *I*; this stud extends all the way through the carriage and its lower end engages the cam groove in the barrel cam *H*. In order to obtain a dwell at the time the kneading takes place this groove is cut straight, of course, allowing the carriage to remain stationary at the end of the stroke during the four seconds' space of time required for kneading the type into the matrices. On the outer end of this cam shaft is located a smaller cam *J* which operates an indexing pin, serving to hold the turret stationary while the type is being kneaded. The location of the driving shaft, worm, wormwheel, carriage and turret may be clearly seen by referring to the rear view of the machine shown in Fig. 4.

The indexing of the turret is effected through a gear *K* on the end of the turret shaft which is operated by another gear *L* on the carriage proper. Gear *L* is, in turn, actuated by a ratchet wheel pinned to the side of the gear and caused to turn through contact with a pawl *M*. This mechanism is all mounted on the side of the carriage and through a lever connection with bracket *N* which is bolted to the frame of the machine, the ratchet wheel, and consequently the turret, is caused to index during the return stroke of the carriage. This mechanism has been omitted in Fig. 5, but is clearly shown in Fig. 3. The cycle of the carriage movements is completed in six seconds—one second for advancing, four seconds in the position for kneading and one second for returning.

The Kneading Movement

The Vetter machine consists essentially of two distinct mechanisms, combined in their action. At one end of the machine the carriage is operated and the turret indexes, while at the opposite end the kneading movement is secured. Power for the kneading operation is brought to the machine at driving shaft *O* and is transmitted to cross-shaft *P* through bevel gearing, and by means of an eccentric upon this shaft a rocking motion is imparted to knuckling section *Q*. The other knuckling section is indicated at *R*, and by referring to Figs. 3 and 6 it will be seen that these sections are rectangular in shape. As has been before stated, the important feature of this mechanism is the fact that it is operated with a minimum amount of friction. The pressure involved in the kneading operation is taken upon the cylindrical faces between sections *Q* and *R* and section *R* and end stop *S* on the framework of the machine. In no instance is there any resemblance of a shaft bearing, the contact points in each of the two cases being practically of no width. The reciprocating movement takes place about an imaginary fulcrum point located exactly at the point of kneading. This may be more clearly observed by noticing in Fig. 6 that the fulcrum point would come in a line with the left-hand faces of the stops *S*. As the matrices are held by means of set-screws in member *Q* so that their faces are in this line, it will be seen that there is absolutely no vertical movement of the matrices during the kneading. The gear teeth which may be noticed at each of the joints of this mechanism are simply for the purpose of keeping the members in line. The gears do not receive any of the kneading pressure, as the teeth are far enough out of engagement so that there is practically no contact, although the pitch line is in line with the bearing points of the members. When the turret has advanced to the kneading position the carriage upon which the turret is located is not quite at its extreme forward position, but during the dwell it is advanced very slightly to take up the distance lost by the receding of the stock in kneading.

Provision is made for holding two blanks at each of the turret stations as indicated in the section of the turret shown

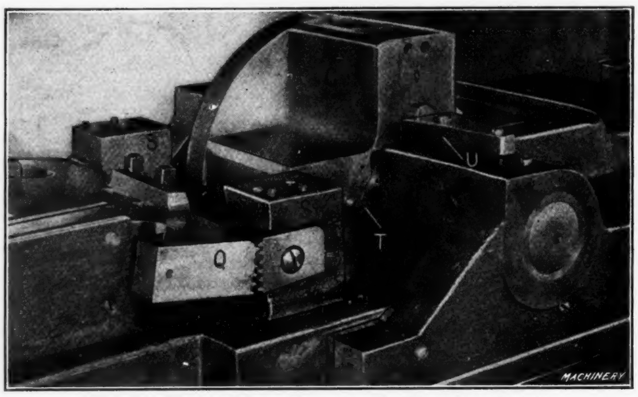

Fig. 6. Close Range View at the Kneading Point

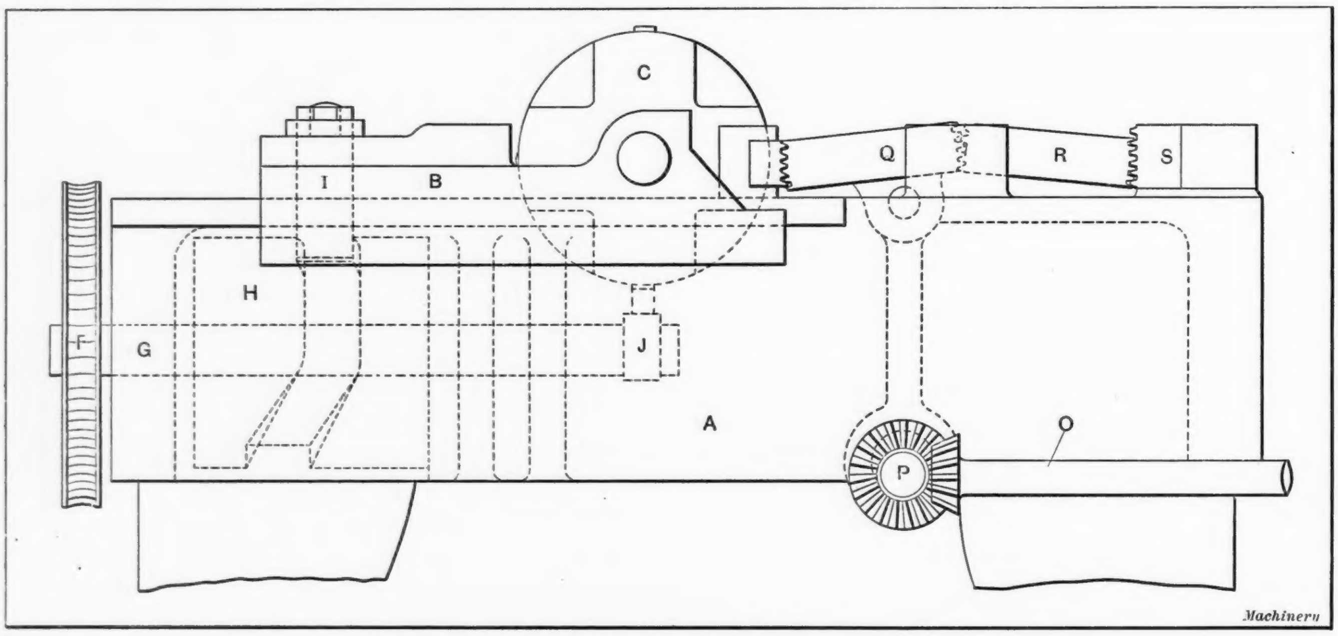

Fig. 5. Side Elevation, showing Principal Features of Machine

in Fig. 7. Decided advantage is secured on this machine by being able to knead the characters upon blanks after the slots have been milled. In the past it has been one of the difficult features of type-making to mill the slot correctly in the finished piece of type, because, on account of its tapered sides, it was almost impossible to center the milling cut with the raised letters upon the face of the type. This is an important matter because in action an uneven slot means a crooked type. On the Vetter machine the slots are milled in the blanks first.

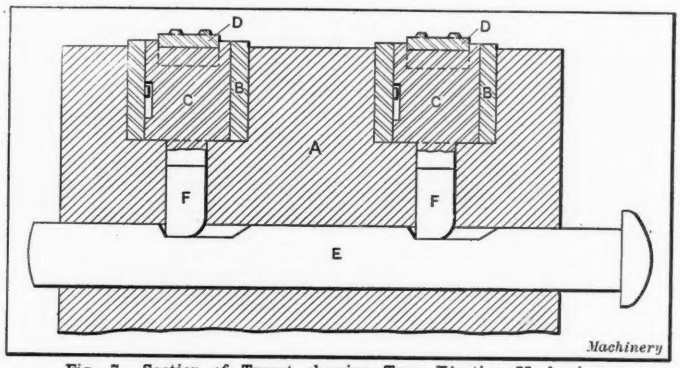

Fig. 7. Section of Turret showing Type Ejecting Mechanism

Referring to Fig. 7, the body of the turret is indicated at *A* and into this member are set the type holders *B*. Within the type holders are fitted two tongues *C*, each the exact thickness of the milled slot in the type blank. The type blanks are fitted over these tongues at the loading position and they are kneaded leaving them in the condition shown at *D*. After the type has been kneaded, side pressure from a cam plate is exerted against the head of bolt *E*, which through a stud *F* causes the tongues to rise and eject the type, allowing it to drop into a pan. In Fig. 6 the end of the tongue-operating bolt may be seen at *T* and plate *U* is used for returning the bolt to its original position.

From Fig. 4 it will be seen that the machine may be stopped or started at will by the engagement or disengagement of the worm gear *V*, engaged by handle *W* and disengaged by lever *X*. Two type having a total of four letters are completed in six seconds or twenty type per minute, and the only attention that the machine requires is the locating of the type blanks in the turret. The surplus metal which extends from the face of the type in a fin is afterward removed by shearing.

* * *

A modest success is better than a gigantic failure.

BUTTON BACK BLANKING AND PIERCING DIE

BY WALTER J. OLDROYD*

A cross-sectional view of an interesting design of punch and die which is used for blanking and piercing metal backs used on trouser buttons is shown in Fig. 1. No. 19 Birmingham gage (0.042 inch thick) ribbon stock is used for making these button backs and the metal is not of a particularly good quality. Fig. 2 shows an enlarged view of one of the finished button backs, and Fig. 3 illustrates the location of the holes in a piece of scrap metal, from which it will be seen that the method of blanking requires very little stock to be wasted.

Referring to the cross-sectional view through the punch and die, *A* is the punch block in which three blanking punches *B* are set in the positions indicated by the cross-sectioned holes in Fig. 3. These punches are held in place by set-screws and are equipped with spring plungers *C* for ejecting the work from the die. The blanking die-holder *D* is screwed to the cast-iron shoe *E*; this holder is made of machine steel and has three tool steel blanking dies *F*, which have a three-degree taper on the outside. *G* is the stripper plate for the dies. The ribbon stock is fed through the die between the guides *H*, and as the ram of the press descends the lever *I*, which is operated by a cam on the ram, moves from the position illustrated until the center line of the lever is in the position shown at I_2. The lever *I* moves the slide *K* through link *J*; and the slide *K* has a transfer slide *L* secured to it, in which there are three holes for transferring the blanks to the piercing punch and die. Before the work is blanked out the transfer slide has reached its extreme left-hand position, and after the blanking operation is completed the spring plungers *C* push the blanks down into the holes in the transfer slide. When the ram starts upon its return stroke the transfer slide moves to the right and delivers the blanks to the piercing die. The transfer slide *L* is held to the cast-iron slide *K* by means of the spring *M*; this spring will allow the transfer slide to remain stationary, regardless of the movement of the slide *K*, so that the mechanism will not be wrecked in event of any obstruction being met.

After the blanks are transferred to the piercing punches they are pushed out of the holes in the transfer slide by means of fingers *N* which act on each blank; these fingers are held down by the tension of springs *O*. Referring to this part of the illustration it will be seen that *P* is the punch stripper

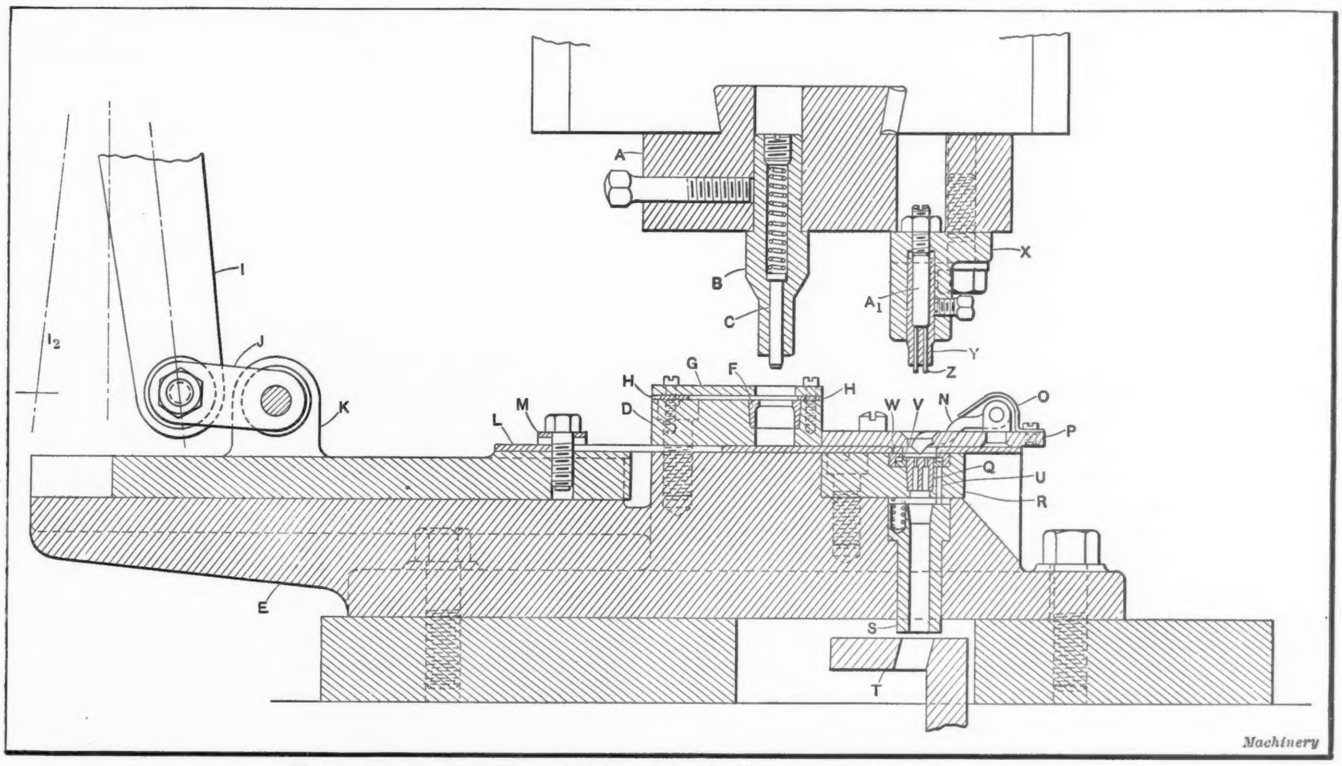

Fig. 1. Cross-sectional View of Button Back Blanking and Piercing Punch and Die

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plate and Q one of the piercing dies. These three piercing dies have a three-degree taper on the sides and are forced into the machine steel die block R. After the blanks have been delivered to the piercing die the ram descends and pierces the four holes, the scrap dropping down through the knock-out tube S. When the slide starts on its return stroke the knock-out T lifts the tube S, which, in turn, forces up the three pins U. These three pins raise the die stripper V so that the blanks are on the same level as the bottom of the transfer slide, and when the latter comes forward with a fresh supply of blanks it pushes the pierced blanks off onto the side of the press. The height to which the stripper V can be raised is limited by the stop W screwed onto the die block. The knock-out tube S is returned to its original position by the tension of the small coiled spring which is carried in a socket at its upper end, and the stripper V is returned by the tension of the springs O acting on fingers N.

The construction of the piercing punch is worthy of more than passing consideration. The steel castings X for the

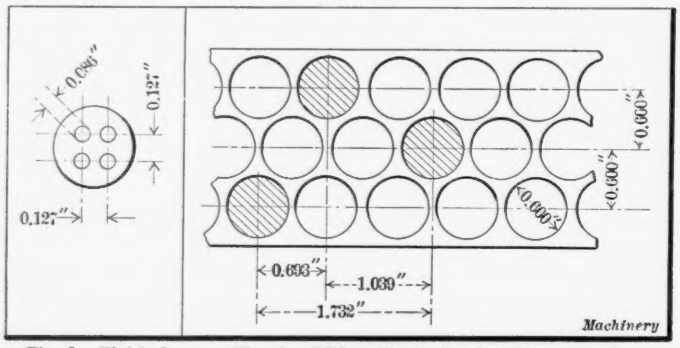

Fig. 2. Finished Button Back

Fig. 3. Ribbon Stock showing Arrangement of Punches

punch-holders are carried in stock, for these castings constitute the punch-holders used for producing a large variety of work. The punch-holders X carry the tool steel pins Y, which are not hardened. These pins are drilled to receive the four drill rod piercing punches Z; the upper ends of these drill rod punches are slightly upset to prevent them dropping out of Y. A hardened tool steel plug A_1, is held in place on top of the four drill rod punches Z by means of the case-hardened set-screw and check-nut. In event of one of the piercing punches breaking, it is merely necessary to cut off a piece of the drill rod, upset it on one end, then harden it and place it in position in Y. Just enough pressure is put on the set-screw to hold the drill rod punches Z in place, but not enough to push Y out of place.

The factory in which this punch and die is used manufactures a large variety of button blanks which are supplied to outside firms in addition to being used by the manufacturer. In many cases it is possible to use the same set of tools for several different styles of button backs, as a slight difference in the outside diameter of the blank will not waste enough stock to justify the expense involved in producing a new set of tools for this particular class of work.

* * *

A somewhat novel arrangement has been made between two German machine tool builders. According to the *Mechanical World*, the Maschinenfabrik Augsburg-Nürnberg and the Ludwig Loewe & Co. Aktien-Gesellschaft have agreed to interchange apprentices, and have made an arrangement by means of which an apprentice, after having completed the period of his training in one shop and expressing a desire for a change, will be taken over by the other concern. While absent, he is supposed to write at stated intervals about his work, and thus keep in touch with his first employer. It is assumed that the apprentice will eventually return to the firm that began his training and that the experience gained elsewhere will make him more valuable than if he had remained in one place.

* * *

As a binder for a cement to stand high heat (1475 degrees F.), use sodium silicate (water glass) diluted with rainwater until a specific gravity of 20 degrees on the Baumé hydrometer is obtained. Sand or quartz may be used in the cement to give the proper consistency.

BENJAMIN LAWRENCE AND COST-KEEPING

Benjamin Lawrence started a machine shop in a thriving Connecticut town fifty or sixty miles out of New York, in the early seventies. Benjamin was young; he worked hard and his shop grew. As his first success came long before the motor car, he had a chance to keep his earnings, and by and by he found himself in possession of a fine profit-producing plant. Benjamin was a man of the old school. There were not many systems in his shop, and those that he had were not very rigidly adhered to. He had a kind of cost system of his own, which consisted largely in comparing bank balances from year to year; and as these balances continued to add ciphers at the right end, he did not worry much about card-index systems.

But as Benjamin grew old, he concluded that it was time to retire. Younger hands were to grip the helm. He sold out, and those who bought his plant had no cause to complain. Judging by the profits of previous years the investment should net twelve per cent. Of course some things about the shop were old-fashioned, but the buyers were men with modern ways who knew how to change for the better. They were experts on systems and methods, and had the time of their lives changing over the old shop to fit their ideal. They became so expert that they could tell the price of a wing-nut to a tenth of a mill, and their chief cost-keeper could keep himself in luxury and comfort—in his mind—on the interest of savings that were to result. The men worked as by clock-work. A minute-and-a-half for this and seventeen seconds for that; if a man lost three minutes looking too long at the drawing before starting to work on a new piece, it was pretty sure to show up on the time-keeper's record and in the cost data.

When the system had been all worked out fine, the new owners felt a pardonable pride in their achievement, and they could not sleep well nights until Benjamin had been down to the shop to see the improvement. The old man did not say much, but there are those who claim they saw him shake his head. He was too old to appreciate these modern improvements!

A year went by, but there was no twelve per cent profit. Another year passed and the result was no better. Then the new owners began to worry. Why could they not do what old man Lawrence had done? Why were their profits less than his when they produced so much more economically?

Finally Benjamin was called into consultation. The old gentleman had followed the events in his shop quite closely. He went over everything again; he looked into this and into that, inspected systems and rate cards, and time records and cost diagrams, and finally when convinced that he had found the cause of the trouble he smiled broadly and said: "Well, you see it's just like this with an old-fashioned fool like myself; when he makes a dollar he never thinks of spending seventy-five cents of it to find out *how* he made it!"

* * *

THE SUPPLY OF EMERY

The world's supply of emery comes from some of the Greek Islands, principally Naxos, and from Asia Minor near Smyrna. Emery to the value of $250,000 is imported annually into the United States. During the past year, some American manufacturers have had difficulty on account of delays in emery shipments, due partly to the disturbed conditions in the Balkans and partly to a strike for higher wages among the workers engaged in obtaining the emery. A bill regulating the emery trade was recently passed by the Greek chamber. This bill provides that the minimum selling price of ordinary Naxos emery is to be $12.54 per metric ton (2205 pounds), and emery of the highest grade must not be sold for less than $21.23 per metric ton. The grading of the mineral will be under governmental control.

* * *

To solder steel to cast iron, first copperize the cast iron surface with vitriol. It is necessary that the cast-iron surface be thoroughly cleaned and polished before the vitriol is put onto it. After having applied the vitriol, allow the surface to dry thoroughly and then solder the steel to the copperized surface the same as in ordinary soldering.

MANUFACTURING GREAVES-KLUSMAN ENGINE LATHES

SOME TOOLS AND METHODS EMPLOYED IN MAKING GEAR-BOXES, APRONS AND OTHER PARTS

BY DOUGLAS T. HAMILTON*

Some of the most interesting tools and methods used in producing the engine lathe manufactured by Greaves, Klusman & Co., Cincinnati, Ohio, are illustrated and described in the following. In Fig. 1 are shown the tools and jig used in drilling, boring, reaming and facing the quick-change gear-box, shown removed from the jig at *A*. Twenty tools, not counting the numerous bushings, are used in machining this casting, which is placed in the jig after it comes from the planer and milling machine and finished complete without being removed. The casting is located in the jig by a tongue, which is also used as

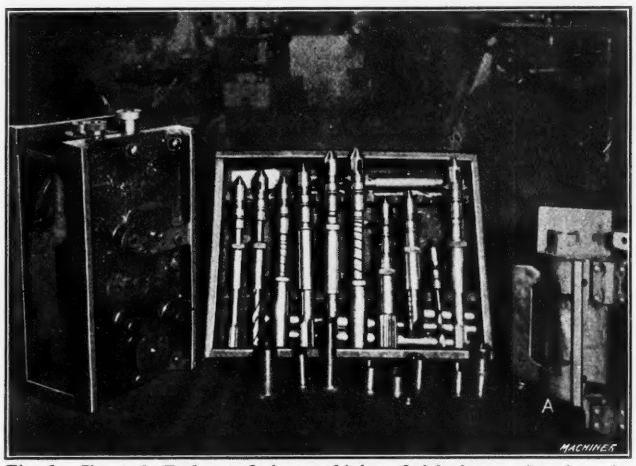

Fig. 1. Jig and Tools used in machining Quick-change Gear-box for Greaves-Klusman Engine Lathes

a locating point when this unit is assembled on the finished bed of the lathe. The box for the tumbler shaft is milled before the jig machining operations, and this surface is used as a locating point for endwise location in the jig.

Briefly stated, the machining operations performed on this quick-change gear-box in the jig consist in drilling, boring, reaming and facing the following holes: Tumbler shaft holes—one in each end; cone shaft holes—one in each end; feed rod holes—one in each end; front shifter lever holes and lead-screw gear eccentric hole, the latter being drilled and tapped. In addition to these operations four clamp bolt holes are drilled, as well as eight holes for the caps for the cone-gear

Fig. 2. Jig and Tools used for machining Double-plate Lathe Aprons

shaft bearings; also four of the bosses are faced with counterbores. Putting the work through without removing it from the jig until all of the machining operations are completed goes a long way toward insuring interchangeability of product.

Jig and Tools for Machining Lathe Aprons

The jig and tools used for machining the double-plate apron are shown in Figs. 2 and 3. Fig. 2 shows the jig in place on the base of the radial drilling machine, where all the operations are accomplished, and Fig. 3 shows a view of the interior of the jig—the top plate being removed—and also the apron and back plate which are machined in it. Twenty-five separate tools are used for machining these castings complete. The back plate, which is shown at *C* in Fig. 3, is drilled, reamed and faced at the same time that the apron is being machined. The apron is located in the jig *B* from all four corners on corresponding finished surfaces in the jig. It is located from the end by the bosses, and is clamped in place by four screws directly in line with the bosses *a* in the jig, these being machined on the under side to act as locating points.

After the apron *A* is clamped in the jig, the back plate *C* is next put in place. This is located on the apron by a groove cut in its surface which fits a corresponding tongue on the apron. When the back plate has been properly located, the removable plate *D* is put in place and properly located by two No. 4 Morse taper sleeves *b*, which fit into corresponding taper holes in the bosses *a*. The top plate is held in position by four bolts *c*, two of which pass up through the tapered sleeves *b*. Three clamping screws in the removable plate *D* are used to hold the back plate tightly against the apron *A*.

Some idea of the kind of work performed in the jig shown in Figs. 2 and 3, may be obtained from a brief outline of the operations accomplished. Five holes are drilled in the top edge of the apron, four of these being used for bolting it to the carriage, and the fifth hole for the chasing dial indicator. The operations performed from the end of the apron are: Boring and reaming the holes in each end for the feed-rod bearing;

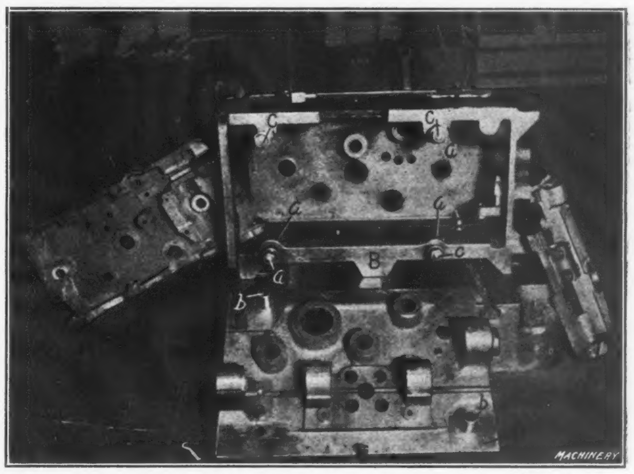

Fig. 3. Closer View of Apron Jig shown in Fig. 2, with Work Removed

performing the same operations on the holes for the double bevel pinion, and boring and reaming the hole for the lead-screw. On the rear side of the apron, the following operations are performed through the removable plate *D*: Drill six holes for bolting the back plate to the apron; drill and ream one dowel pin hole; drill, ream and bore, rack pinion hole, first stud hole, lateral friction hole, and cross friction shaft hole. From the front of the apron the following operations are performed: Drill, bore and ream first stud hole and rack pinion hole; and bore, face and counterbore lateral friction hole, and cross-feed friction hole. In addition to this, the following holes are bored and reamed: Bevel gear stud hole; bevel pinion shifter shaft hole; three locating holes for shifter lever, for locating the double bevel pinions in the three positions—right or left pinion in contact and pinions in the neutral position. The hole for the half-nut cam is also drilled and reamed in the jig shown in Figs. 2 and 3, and in fact both the apron and back plate are machined complete without being removed.

A Counterboring Tool

The tool used in counterboring the holes for the friction cross-feed and lateral-feed shafts is worthy of special mention. This tool is shown at *E* in the spindle of the machine in Fig. 2, and in detail in Fig. 4. It consists principally of a shank *A*, which is threaded for the reception of the counterbore *B*, and two locking collars *C*. The shank is made from low-grade tool

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steel and is left soft, and a hardened and ground bushing *D*, which is held in place by a screw and washer, as shown, acts as a pilot. The body of the holder is made a good running fit in the cast-iron bushing *E*, and is separated from the locking washers by a feeler *F*, which is 1/8 inch thick.

In use, the shank of this tool fits in a quick-removing socket in the spindle of the radial drilling machine, and as the spindle of the machine is brought down, the bushing is made to enter the desired hole in the jig, being prevented from rotating by the pin *G*. The locking washers *C* are adjusted so that when the counterbore has penetrated to the proper distance in the work, they come in contact with the feeler *F*, which of course is resting on top of the bushing *D*. This makes it practically impossible for the counterbore to penetrate beyond the proper depth, and provides a quick and accurate means of determining when the correct depth is reached. With the aid of this feeler it is a simple matter to counterbore a hole to within 0.0005 inch of the depth required, the feeler being practically as sensitive as an ordinary micrometer.

Cast-iron Jig Bushings

All the slip or removable jig bushings used by Greaves, Klusman & Co. in the manufacture of their engine lathes are made from a good grade of gray cast iron, in preference to tool or machine steel. It is claimed that the cast-iron bushing gives satisfactory results, and, what is still more important to the

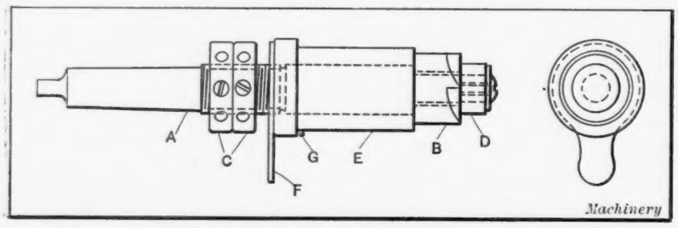

Fig. 4. Counterboring Tool designed for boring to Correct Depth

manufacturer, its first cost is considerably less than that of a tool-steel bushing. Drill bushings made from either machine or tool steel have to be hardened, not only to prolong their life, but to prevent the drill or tool used from seizing in them. The hardening of the bushing distorts it to a greater or less extent, thus making it necessary to grind it inside and out (especially when of the "slip" type) and where additional refinement is desired the hole in the bushing is sometimes lapped.

Contrast with this the cost of making a cast-iron bushing. This can be completed in less than one-fifth the time, and the material not only costs much less but it is also more easily worked. The bushings need not be hardened, and in fact can be practically completed in the lathe. When a good smooth surface is desired, this can be easily and quickly obtained by lapping, although a reamed hole is good enough for all practical purposes. Another point which adds greatly to the decreased cost incident to the use of cast-iron bushings is the fact that the tool shanks can be made from a low grade of

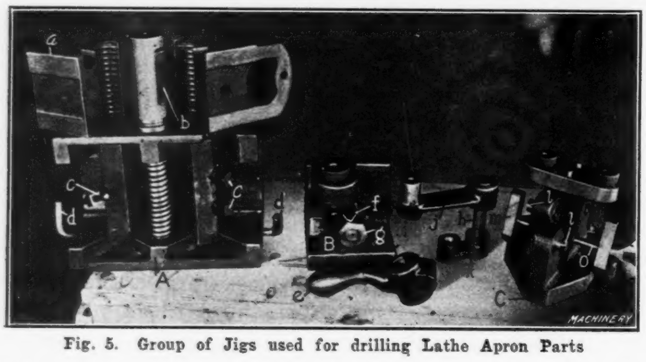

Fig. 5. Group of Jigs used for drilling Lathe Apron Parts

tool steel and need not be hardened or ground. This is impossible with a hardened tool-steel bushing, especially if the tool is used for working cast iron and is operated at a high speed without being properly lubricated and well taken care of.

It is a well-known fact that a soft steel shaft running in a cast-iron bushing makes an excellent bearing for normal periphery velocities, so that as far as a bearing is concerned, the cast-iron bushing fills all requirements. By making the tool shank from low-grade tool steel and the cutting portions from inserted pieces of high-speed steel, a very cheap tool of maximum cutting capacity and long life will be produced. It is also possible to renew it when worn below size at a very small cost. To provide means for lubricating the tool shanks when working in the cast-iron bushing, the shanks of all tools are made with spiral oil grooves, as is clearly indicated in Figs. 1 and 2.

A tool-steel jig bushing, properly hardened and ground, will last for years, but this is of little or no advantage to a manufacturer who is continually on the lookout for improvements, which of course necessitates making new jigs and fixtures to

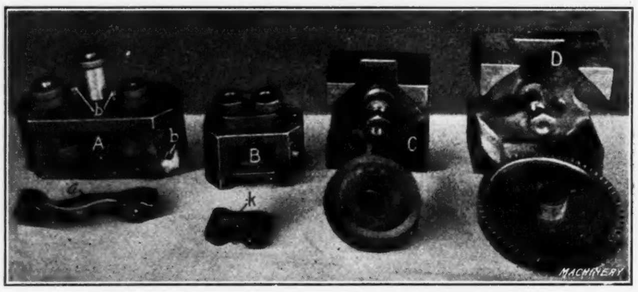

Fig. 6. Another Group of Jigs for Apron Parts

handle the improved parts. The jigs in many cases can be used again by making slight additions or alterations, but this is not generally the case with the bushings, which must be annealed, machined, hardened and ground if it is desired to use them again. The cost of doing this hardly warrants using the old bushings; consequently, they either go into the scrap heap or are relegated to the store of out-of-date equipment. This is not the case with cast-iron bushings, as it is a simple matter, in many cases, to work them in at a very little expense. Another point which has not been mentioned is the fact that if proper care is exercised a cast-iron bushing will usually last as long as the particular model of the machine on which it is used. Consequently it also fills the bill in this respect. The writer was shown cast-iron bushings which have been in use for over a year that were practically as good as when they were first made—and just as accurate as to size.

Drill Jigs for Machining Apron Parts

Some of the principal jigs used in machining a few of the apron parts are shown in Figs. 5 and 6. At *A* in Fig. 5 is

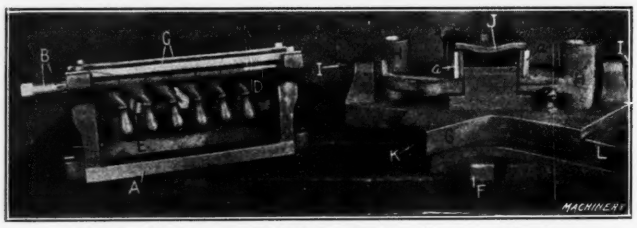

Fig. 7. Two Types of Milling Fixtures for Apron Parts

shown the jig used for drilling the cam pin holes in the half-nut *a*. The jig consists primarily of a cast-iron box into which is fitted a plug gage *b* which has the same pitch and shape of thread that is cut on the lead-screw of the lathe. The two parts *a* of the half-nuts are located sideways in the jig by a machined groove, and are held tight up against the plug gage *b* and the machined base of the jig by set-screws *c*; these are held in swinging straps, which are retained in place by the bent pins *d*. By locating the half-nut in this manner when drilling, it is possible to get the holes in the proper position with respect to the center of the lead-screw and the grooves in the cam which is used for opening and closing the half-nut.

At *B* in Fig. 5 is shown the jig for drilling the clamp screw hole in the lever *e*, which is used for operating the half-nut opening and closing cam. The lever *e* is located from the hole on the stud *f* of the jig, and is clamped by a quick-removing nut *g*. This nut has only one full thread and the hole is filed oblong in shape on both sides, removing the thread entirely from opposite sides of the hole. This gives the nut a sort of cam action, making it possible to either loosen or tighten it by giving it about 3/4 or a full turn, without reducing its effectiveness as a clamping device.

The type of jig used for drilling the half-nut locking link is shown at *A* in Fig. 6. This consists of a cast-iron box having two bosses cast integral, which are machined and act as locat-

ing points for the link *a*. The work is located endwise from the boss, and is held in place by the three screws *b*, two of these holding the work down on the machined bosses in the jig. A 5/16-inch hole is drilled completely through the small end of the link, whereas the other end is drilled and reamed with a 19/32-inch drill and ⅝-inch reamer, respectively—two slip bushings *c* being used.

At *C* in Fig. 5 is shown the jig used for locating and drilling the pin holes in the link and handle for the apron feed reverse. The stud *h* is first placed in the hole *i* of the jig, then the handle *j* and link *k* are put on the stud, being located in the proper relative positions by pins *l*, against which the bosses of

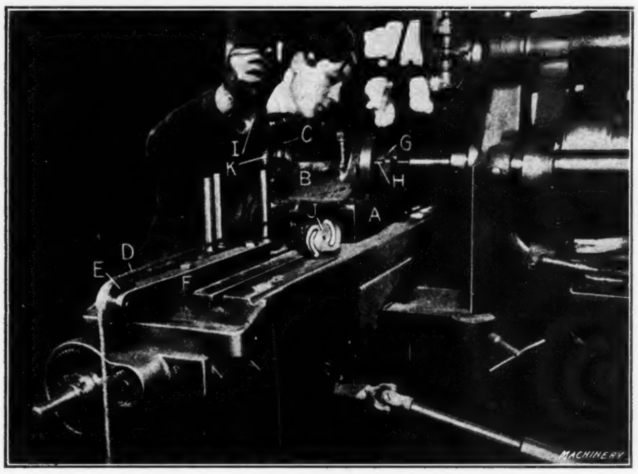

Fig. 8. Fixture for milling Half-nut Operating Cam Grooves

the handle and link rest. The three members are held rigidly in position while the pin holes are being drilled, by the heel clamps *m*, which are drawn together by the wing nut *n*, working on the screw *o*. The jig used for drilling the double bevel pinion shifting link *k*, Fig. 6, is shown at *B*, and as will be seen is similar in design to the one shown at *A* in the same illustration.

All the gears used in the aprons of Greaves-Klusman engine lathes are made from steel forgings, and in order to have the friction gear work efficiently it is necessary to furnish it with a cast-iron boss. This is accomplished by making the friction from a separate disk of cast iron, and then fastening this to the drop-forged friction gear by four ⅜-inch cap-screws. The type of drill jigs used for this purpose are shown at *C* and *D*, respectively, in Fig. 6. The jigs are of plain open construction, furnished with studs by which the work is located and held, quick-acting nuts of the type shown at *g* in Fig. 5, being used for clamping. The three bushing holes are laid out in each jig so that the parts drilled in them are interchangeable.

Milling Fixtures for Apron Parts

A gang type of milling fixture which is used for splitting twelve lead-screw half-nut operating handles, is shown to the left in Fig. 7. One of the handles which has been split in this fixture is more clearly shown at *e* in Fig. 5. The fixture *A* is made from an iron casting having two uprights which carry the arbors *B* that hold the work, and also the guide strips *C* for the slitting saws. The two arbors which are made to fit the hole in the handles are screwed into the bracket or upright at the right, and to provide for the curve of the handles, washers *D* are placed between the last handle and the bracket. The handles are located in the proper position for slitting by a web *E* against which the turned portions of the handles bear. In use, this fixture is held in the ordinary way on the table of the milling machine, and two slitting cutters are held on the cutter arbor, so that both rows of handles are completed at the same time. The guides *C* afford means of setting the slitting saws quickly in the proper positions.

Fig. 9. Fixture used in testing Alignment of Cross-slide Screw and Gage for testing Apron Shifter Gears

To the right of the illustration Fig. 7 is shown another milling fixture which differs considerably from that just described. This fixture is used for milling feed-gear driving shaft brackets, and is built to hold two castings at a time. I, consists principally of two castings *F* and *G*, the former being held to the milling machine table in the usual manner, while the top casting is pinned by a stud to the base *F*, but is free to be swung around when the spring-operated locating plunger, held in box *L*, is withdrawn. The brackets *H* which are to be milled on the faces *a* and *b* are held on machined seats provided on the center portion of the top member of the fixture, and are also located from the bosses as indicated. The castings are held up against the machined seats of the fixture by set-screws *I*, and are clamped by a bridge strap *J*. As the faces to be machined are located at right angles to each other, the fixture is provided with locating slots *K* (one of which is shown) so that the top member can be swung around through 180 degrees. The machining is done by two straddle milling cutters, held the correct distance apart by spacing washers.

The type of fixture used for milling the two grooves in the half-nut cams, is shown in place on the milling machine table in Fig. 8. This consists of a cast-iron base *A*, held to the milling machine table, in which the casting *B* carrying the rotating head slides. The movement of the casting *B* is controlled by a cam on the rotating head *C*, which is kept in contact with a roller by the wire rope *D* and a suspended weight. In order to make the movement of the head as sensitive as possible to

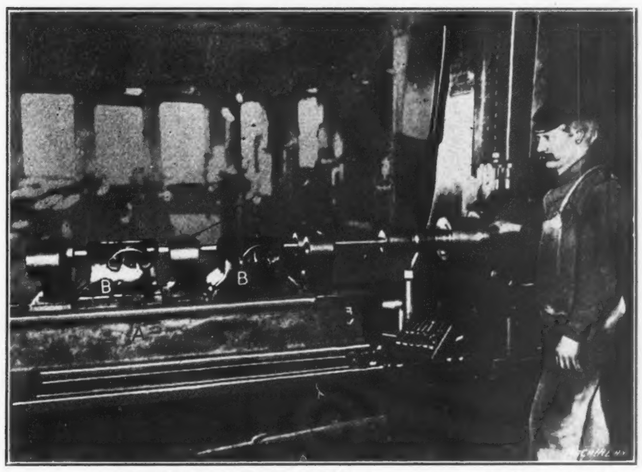

Fig. 10. Boring Tailstock Spindle Holes in a Horizontal Boring Machine

the action of the cam, and also to lift the rope from the table, the wire rope is made to run over a roller *E* held in the bracket *F*, which is bolted to the table.

The work *G* is held in a draw-in collet and is located in the proper position by a pin *H* in the front plate of the head. A stop is held on the milling machine table, so that the work can be brought into the proper relation with the end milling cutter, and there is also a stop provided to govern the distance that the cutter penetrates into the work. The head is rotated by the operator by means of the handle *I*, which operates a worm meshing with a worm-wheel held on the rotating head. After the first cam groove is cut, the table of the milling machine is withdrawn from the cutter, and the head indexed ½ turn (180 degrees) thus bringing the work into position for milling the second groove. Stops on the rotating head locate it in the two positions for cutting the grooves. One of these finished cams is shown at *J* lying on the table.

Gage for Apron Shifter Gears

To the right of Fig. 9 is shown a fixture which is used in testing the running contact between the double bevel pinions *A* and the bevel gear *B*. The fixture *C* consists of a casting provided with three vertical bosses. The rear boss *D* contains a stud on which the bevel gear *B* is held, whereas the two end bosses are drilled and reamed for the reception of the stud *E* on which the double pinion sleeve is held, the two pinions

being made integral with the sleeve. The left-hand boss is extended around to the rear of the fixture, and is slotted to fit the two gage blocks *F* and *G*, which fit into the groove in the double pinion sleeve when the latter is shifted along the stud to bring the two pinions alternately in mesh with the bevel gear. By this means it is possible to test the running contact of the bevel pinions with the gear and in this way insure interchangeability of product. It might be mentioned here that masters of both gears and bevel pinions are provided, so that as the teeth in the bevel pinions or gear are cut, they can be tested with the masters.

Fixture for Testing Alignment of Carriage Cross-feed Screw

Another testing fixture which greatly assists in obtaining interchangeable lathe parts is that for the carriage cross-feed screw shown to the left in Fig. 9. This comprises a casting *H*, which is made to fit the dovetail projection on the top of the carriage; it is furnished with an adjustable gib and carries a rod *I* of the same diameter as the cross-feed screw. Rod *I* carries on its outer end a nut *J*, which, when the fixture is put in position, takes the place of the cross-feed screw nut. The other end of the rod is used as an indicator for determining the correct alignment of the cross-feed screw bearings. This fixture is also used for testing the alignment of the sliding block of the taper turning attachment with the cross-slide.

Fixture for Boring Tailstocks

In boring the hole in the tailstock for the spindle, two castings are held at one time on a 6-foot lathe bed, as indicated in

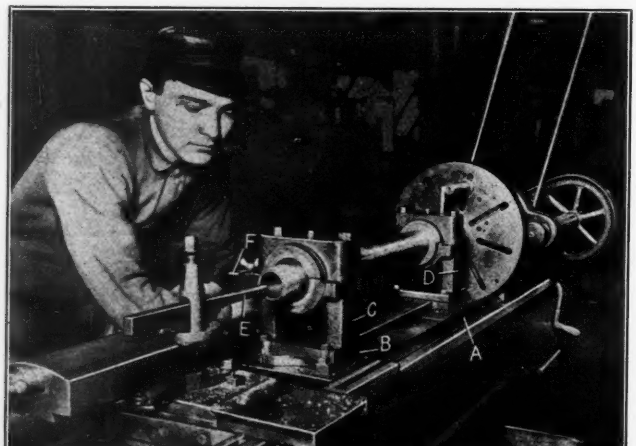

Fig. 11. Boring the Taper Hole in the Nose of the Lathe Spindle

Fig. 10. The lathe bed *A* is clamped to the bed of a Fosdick floor-type horizontal boring machine, and the tailstocks *B* are held in the same manner as when in place on the completed lathe. Three steel bushed bearings *C* are provided for guiding the boring bar. Three cuts are taken—two roughing and one finishing—the cutters all being of the correct diameter and held in place by cone-head screws. This same fixture is used for boring out the head, the center bracket being removed for this purpose, and only one casting is machined at a time.

Boring Taper Hole in Nose of Spindle

The fixture used for boring the taper hole in the nose of the lathe spindle is shown in Fig. 11, and as can be seen is used on a regular engine lathe. It consists of a bottom plate *A* which rests on the vees of the lathe, and a top adjustable member *B* to which the two brackets *C* and *D* are held. The lathe spindle to be bored is held in babbitted bearings by caps which have to be removed to insert the spindle. The top part of the fixture is set to the correct taper angle, allowing the boring tool to travel in a straight path parallel with the axis of the lathe centers. The boring tool *E* is held in the tool-post of the tool-slide, and its cutting edge is set to the correct height—directly on the center—by a hardened tool setting block *F*, which is held on a projecting arm of the front bracket. The hole is bored almost to the exact size, only sufficient stock being left to take a light finishing cut with a taper reamer. The work is rotated by a stud, held in the faceplate of the lathe, which comes in contact with a pin attached to the lathe spindle being bored.

STEEL WORKS AND ROLLING MILLS, 1909

Statistics for the steel works and rolling mill industry in the United States for 1909 are presented in detail in a bulletin issued by the Bureau of the Census, Department of Commerce.

Steel works and rolling mills constitute one of the largest industries in the country, the total value of products for 1909 being $985,722,534. The number of establishments was 446, and the number of persons engaged in the industry was 260,762 of whom 240,076 were wage earners, the amount paid in wages being $163,200,758.

The total number of establishments, including forges and bloomeries has not varied greatly, the increase for the forty years since 1869 being only 5.7 per cent. In the case of value of products, however, the amount for 1909 was over seven times that for 1869 and the average value of products per establishment shows a progressive increase with each census —from $325,991 in 1869 to $2,210,140 in 1909. The rate of increase in value of products for the successive decades has been quite uniform, ranging from a minimum increase of 50.6 per cent for the decade 1869-1879 to a maximum of 79.3 per cent from 1889 to 1899. The increase in value of products from 1899 to 1909 is perhaps partly attributable to advance in prices.

The steel-works and rolling-mill industry is concentrated largely in the Middle Atlantic and East North Central states, and in the Panhandle of West Virginia. Of the 446 establishments in 1909, 362, or 81.2 per cent, were located in seven contiguous states—New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, and Illinois. The value of products in these seven states amounted to $897,365,567, or 91 per cent of the total for the United States.

The steel-works and rolling-mill industry comprises three classes of establishments: (1) Those equipped both with furnaces for making steel and with hot rolls for rolling it; (2) those equipped with steel furnaces but not with hot rolls; and (3) those equipped with hot rolls but not with steel furnaces. Most of the largest establishments belong to the first group. All steel plants operated in conjunction with blast furnaces are equipped also with rolling departments. On the other hand, no establishments of the second group have blast furnaces, but all buy pig iron and scrap for steel making. Establishments of the third group include those purchasing their material in the form of ingots, blooms, slabs, or other shapes, pig iron for puddling furnaces, and also the few independent bloomeries.

In the country as a whole combined steel works and rolling mills produced 61.6 per cent of the aggregate value of products in 1909; steel works without rolling mills, only 4.7 per cent; and rolling mills without steel works, 33.8 per cent. These percentages, however, give a somewhat exaggerated idea of the importance of the latter class of mills, because the value of their product consists in considerable part of the value of the crude steel purchased by them from plants of the first two groups. Pennsylvania in 1909 contributed over half (50.7 per cent) of the total value of products; Ohio, about one-fifth (20.1 per cent); Illinois, 8.8 per cent; New York, 4 per cent; and Indiana, 3.9 per cent.

The average number of persons engaged in the industry in 1909 was 260,762, of whom 240,076, or 92.1 per cent, were wage earners; 4286, or 1.6 per cent, proprietors and officials; and 16,400, or 6.3 per cent, clerks. Individual proprietors and firm members were few in number, the industry being mainly controlled by corporations. Of the total number of wage earners in 1909, 34.2 per cent were in establishments where the prevailing hours were 60 per week, or 10 hours a day for six days in the week, while 34.4 per cent were in establishments where the prevailing hours were over 60 per week, and 21.8 per cent where they were 72 per week and over. The eight-hour day is not found to any large extent, only 9.3 per cent of the wage earners being employed in establishments where the prevailing hours were less than 54 per week. The proportion in establishments in which the prevailing hours of labor were 72 or more per week was especially high in Illinois, Wisconsin, and Indiana.

The tendency toward concentration in large establishments is very marked in the steel industry. There is no other industry in which so many plants of great size are found. In 1909,

41.7 per cent of the establishments reported products valued at \$1,000,000 or more each, as compared with 31.6 per cent in 1904. This group of establishments in 1909 included 23, and in 1904, 15 with products in excess of \$10,000,000 in value. The value of the output of the establishments with products valued at \$1,000,000 or over formed 91 per cent of the total for all establishments in 1909, as compared with 84.6 per cent in 1904, and that of the establishments with products valued at \$10,000,000 or over constituted 43.2 per cent of the total in 1909, as compared with 36.6 per cent in 1904.

In the distribution of the 19,276,237 tons of finished rolled products and forgings made by steel works and rolling mills in 1909 among the principal producing states, Pennsylvania produced 51.4 per cent of the total output of these products in 1909, as compared with 54.3 per cent in 1904. Ohio increased its proportion of the output from 13 per cent in the earlier to 16.1 per cent in the later year. Indiana and Illinois showed higher percentages of the total output in 1909 than in 1904; but those of New York and West Virginia were about the same.

There has been during each decade a marked increase both in the absolute and relative amount of open-hearth steel produced. Basic open-hearth steel constituted 1.3 per cent of the total steel production in 1889, as against 56.2 per cent in 1909. Bessemer steel, on the other hand, although the output increased 153.8 per cent during this period, constituted only 39 per cent of the total production in 1909, as compared with 86.6 per cent in 1889.

* * *

BROACHING A LONG KEYWAY

The J. N. Lapointe Co., New London, Conn., recently fitted out one of its broaching machines for cutting a 1-inch keyway in a cast-iron sleeve 40 inches long. The hole in the sleeve is 6 inches diameter and as the sleeve was not chambered, the keyway had to be cut in solid metal the full length. The principal difficulty in broaching such long work is to provide for discharge of the chips. The accumulation of chips in such long cuts is greater than can be taken care of in the spaces between the teeth when the broach is made in the customary manner. It was necessary to make the cutter bar with staggered teeth or in other words with teeth having a shearing cut. This arrangement of the teeth diverts the chips to the sides, and two recesses were provided on both sides of the cutter bar in the work bushing to receive the chips.

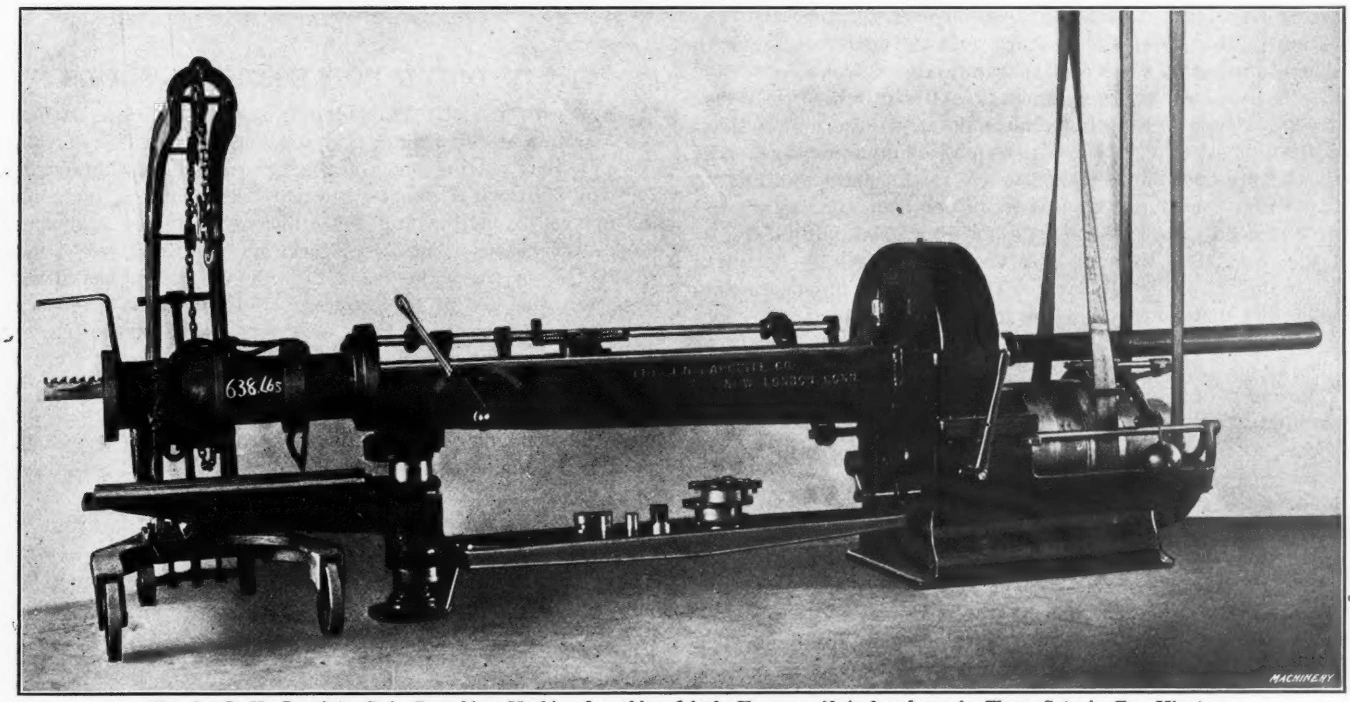

Fig. 1. J. N. Lapointe Co.'s Broaching Machine broaching 1-inch Keyway, 40 inches long, in Three Cuts in Ten Minutes

The weight of the sleeve shown in Figs. 1 and 2 is 638 pounds. It was necessary to handle it by means of the portable shop crane shown. The crane suspended the work and held it in place during the operation, one end of the piece being slipped onto the work bushing which is bolted to the nose of the machine.

The cutter bar does its work in three operations, that is three passes of the cutter through the work cuts the keyway to full depth. A blocking key is provided for raising the cutter bar one-third the depth of the keyway after each cut. The cutter bar is so arranged that it does not require adjustment or raising for each operation; provision is made in the pull bushing connecting with the bar so that it slides up and down at each operation, thus enabling the work to be done rapidly and conveniently. This fact is indicated by the time required

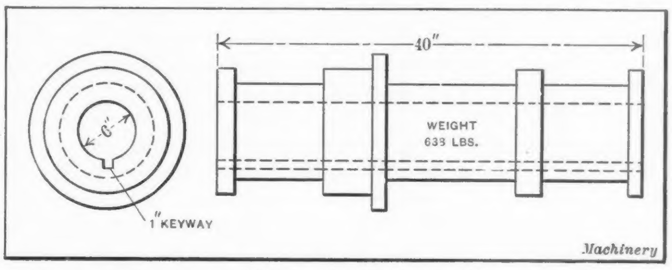

Fig. 2. Work Piece weighing 638 Pounds containing 1-inch Keyway in 6-inch Hole 40 inches long

for cutting the keyway to the full depth, the time being ten minutes to set the work on the machine, cut the keyway and remove the work. The time required by the manufacturer ordering the equipment who had been cutting keyways in similar pieces on a planer, was two and one-half to three hours, and the alignment of the planed keyways was defective as compared with that obtained by broaching.

* * *

ADVERTISING IN STREET CARS

An effective method of utilizing advertising space is being employed to some extent in street cars, the principle being to keep the advertising cards in motion. Instead of being mounted in stationary racks as is usual, the cards on each side of the car are mounted on an endless belt. This belt is traversed by a small motor at the rate of about six feet per minute. Thus about twice as many advertising cards can be shown as when displayed in the usual way. Besides showing a greater amount of advertising matter, the scheme has the additional advantage, which is probably of still greater importance, of keeping the advertisements in motion and thus attracting far greater attention than if they were held stationary.

* * *

Amber-mica fuses at a temperature of about 2500 degrees F. However, mica will fuse readily at any temperature above 1450 degrees F., if certain elements of which mica is composed are in contact with it at this temperature. Such elements are silica, alumina, felspar, etc.

THE MACHINING OF ALUMINUM AND WHITE METALS

BY KURT DEINHARDT*

Some time ago, a manufacturer complained that great difficulty was met with in the working of various white metals, and that there was nothing in the mechanical literature on this subject. The following article, therefore, has been prepared in order to give the most important points on the subject, based on experiments during past years. Besides the well-known bearing metals, there is a long series of white metals which, according to the main constituents, may be considered as aluminum, tin, lead or zinc alloys.

Without considering punched or pressed articles which are not worked upon with cutting tools, there are numerous objects which previously were made from brass or bronze, but which are now, on account of the improved appearance, the reduction in weight, or other properties, made from aluminum alloys or other white metals. Aluminum not alloyed with other metals is also used for a great many machine parts and devices. Commercially pure cast aluminum has a tensile strength of about 14,000 pounds per square inch, which is too low for many purposes. In order to increase the strength, aluminum is, therefore, alloyed with other metals. So-called aluminum-bronze is an alloy of copper with from 5 to 11 per cent aluminum, which increases the tensile strength of the copper from 28,000 pounds per square inch to from 85,000 to 110,000 pounds per square inch. Aluminum-bronze is light yellow and not as heavy as ordinary bronze. It shrinks in

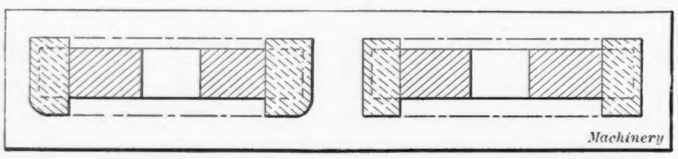

Fig. 1. Rounded Corners are objectionable in Cutters for Aluminum
Fig. 2. The Sharp-cornered Cutter gives Best Results

casting about twice as much as bronze containing tin. The casting is, therefore, often porous, and the increased strength rather imaginary. The casting of aluminum-bronze is a difficult matter and requires especial skill in order to insure success. Alloys containing aluminum as a base and a small addition of other metals are, therefore, of greater value. The alloy with magnesium—magnalium— is especially well-known. Magnalium containing from 3 to 10 per cent magnesium has two and a half times the tensile strength of aluminum and is at the same time lighter; it is therefore especially useful in the building of aerial craft. The addition of magnesium makes the metal firm and less tough, so that it can be more easily worked with cutting tools. If the magnesium content is too great, the metal becomes too brittle and is useless.

The main difficulty met with in the working of aluminum and aluminum alloys is the carrying off of the chips. These become so firmly imbedded between the teeth of milling cutters, counterbores and similar tools that they cannot be removed with a brush. The only way in which to avoid this difficulty is to use the right kind of cutting lubricant. Oil cannot be used, but soapy water gives good results, although not a shiny surface. The best cutting lubricant is kerosene, which gives a mirror finish to the work when the cutting tool is properly ground. The cutting edges of the tools must have sharp corners. Rounded corners, as shown in Fig. 1, are objectionable, and all milling should be done by cutters shaped as in Fig. 2.

For milling flat surfaces, it is preferable to use end mills rather than cylindrical cutters. The mills will cut best if a high cutting speed is used with a moderate feed. The depth and width of the cut is of less importance. A cutting speed of 325 feet per minute can be considered as practicable and from 2½ to 4 cubic inches of metal may be removed per minute, in aluminum.

Rolled Britannia metal is composed of from 90 to 93 per cent of tin, from 4 to 8 per cent of antimony, and from 1 to 2.5 per cent of copper. Cast Britannia metal consists of 80 to 85 per cent of tin, 9 to 17 per cent of antimony, 1 to 3 per cent of copper, and from 0 to 3 per cent of zinc. Cast Britannia metal is less tough than the rolled metal, and is more easily worked by cutting tools. Cast metal can be worked without a cutting lubricant, which is not possible with the rolled metal. With the same cutting speed as is used for aluminum, from 1.25 to 1.5 cubic inch of metal may be removed per minute. The adding of antimony makes this metal more brittle, but also more easy to machine.

The Prussian State Railways use the following composition for white-metal bearings: Tin 83 per cent; antimony, 11 per cent; copper, 6 per cent. The Austrian Northwest Railway uses: Tin, 82 per cent; antimony, 12 per cent; copper, 6 per cent. Several English railways use from 73 to 77 per cent of tin; from 15 to 19 per cent of antimony, and from 7 to 9 per cent of copper.

The lead alloys are similar to the tin alloys with regard to their machining. The addition of antimony makes the metal less tough and, therefore, more easy to work. Stuffing-boxes for locomotive cylinders are made of an alloy consisting of 80 per cent of lead, 8 per cent of antimony, and 12 per cent tin. Pure lead is very difficult to work, and a very small feed should be used. The width of the cut can be of fair proportions, so that from 1.75 to 2 cubic inches of metal may be removed per minute.

Zinc is most commonly used for cast objects which are to be plated with copper or nickel. Zinc is also used in bearing metals because it is cheaper than tin and stands wear better than lead. This bearing metal is composed of from 60 to 80 per cent of zinc, from 10 to 35 per cent of tin, 5 per cent of copper, and a small percentage of antimony. Zinc alloys can be easily machined dry. They have the disadvantage that the castings are somewhat porous, which causes trouble in the plating.

It may be generally remarked that it is impossible, when working white metals, to take full advantage of the efficiency of the modern machines or cutting tools, and that an increase of the antimony or magnesium content makes an alloy of the metals mentioned more easily machined.

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* * *

CHAIN DRIVE FOR MACHINE TOOLS

Tests were recently carried out by Messrs. Hans Renold, Ltd., of Manchester, England, to determine the value of chain drive on gear cutting machines, and reported in *Engineering*. Two No. 6 Brown & Sharpe automatic gear cutting machines, one driven by belting and the other by a Renold high-speed chain, were used. The belted machine was arranged exactly as supplied by the makers and the other machine was altered to permit the use of chain drive. Both machines were employed in cutting silent chain sprockets of 1¾ inch pitch, the cutting speed being 75 feet per minute. The results were as follows: It was found that with the belt-driven machine, the maximum feed practicable was 3¼ inches per minute, while with the chain-driven machine, the maximum feed could be raised to 5¼ inches per minute. The weight removed per minute was 1.66 pound in the case of the belt-driven machine and 2.68 pounds in the case of the chain-driven gear cutter. This increase of 60 per cent in output involved an increase of only 10 per cent in the power necessary for the chain-driven machine. In a second series of tests, both machines were run to give the same output; the feed of the belt-driven machine being 3¼ inches per minute, while that of the chain-driven was reduced to the same figure. In this case the chain-driven machine required 7.1 horsepower, while the belt-driven machine required 8.3 horsepower. Mr. Renold further claims that he has found by experience that the milling cutters will last longer and require less frequent grindings when the belt drive is replaced by a silent chain, this being due, no doubt, to the fact that the vibrations due to the slipping of the belt are minimized by the use of the chain.

* * *

On December 31, 1912, the records of the International Aeronautical Federation showed that there were 966 certified aviators in France, 376 in Great Britain, 335 in Germany and 193 in the United States. There were also 23 certified airship pilots in Germany, 22 in France, 11 in Great Britain and 3 in the United States.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A MOLDING DIE FOR FIBER INSULATIONS

The punch and die illustrated in Fig. 1 is used to form the knurled thumb-nuts or "binding post caps," as they are familiarly called, which are used to connect wires to electrical apparatus. Fig. 2 shows the two blanks used for this purpose and the finished nut. Referring to this illustration, *A* is a metal core which is threaded on the inside to screw onto the binding post. *B* is a section cut from a fiber tube, which is molded over the metal core by the action of the punch and die, the finished product being shown at *C* in the illustration. The metal core is provided to prevent the screw from wearing, while the fiber shell protects the operator from electrical shock. The fiber shell is corrugated on the outside and pressed onto the inner metal shell at one stroke of the punch press.

The molding die consists of a body which forms the main part of the mold, a steel plate which is corrugated to produce the corrugations on the nut, and a punch which is corrugated in such a way that it fits into the plate. The body of the die is fitted with a stripper, which also constitutes the bottom of the mold, and the punch has a spring pilot pin that locates the work in the die.

The blanks are produced as follows: The steel core is made on a screw machine where it is tapped, knurled on the outside and cut off to the proper length. The fiber insulation is bought in the form of tubes, from which the blanks are cut off to the proper length, making an allowance for compression and shortening, due to the pressure used to force it to "flow." To operate the die, a steel core is placed in the slight recess in the face of the die stripper. A fiber blank is dropped over the core, on which it fits loosely. As the punch descends, the spring pilot brings the steel core into its proper place. The corrugations on the punch enter those on the die, and as the pressure on the fiber increases, it flows or forms itself into the knurling on the steel core, at the same time filling the vertical corrugations on the plate which molds the insulation to the required shape. The fiber also flows over the top of the core until it fills all the space not occupied by the pilot pin. The end of the punch is slightly cupped so as to form a rounding top on the nut. As the punch leaves the die, the stripper forces the nut out ready for the operation to be repeated.

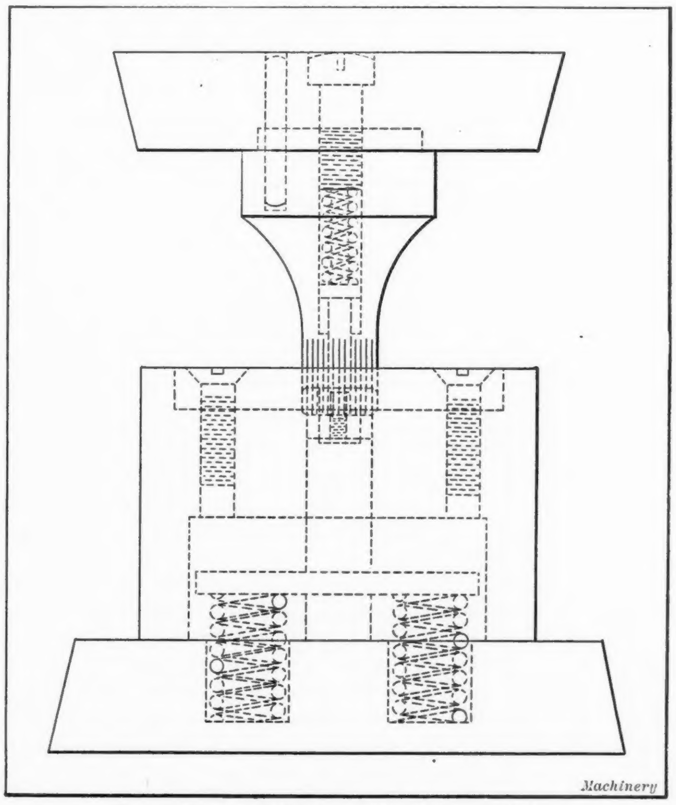


Fig. 1. Punch and Die for molding Fiber Insulations

This die is both simple and efficient. The steel plate which is set into the top of the mold was made in this way so that in case a careless workman should not set the die right in the press, the whole die would not be ruined but only the punch and plate. The corrugations were cut with a broach, the shape of which exactly corresponded to that of the punch. It was necessary to corrugate the punch because the pressure is so great that the fiber would flow upward in each corrugation leaving a thread on each point. This is overcome by filling the corrugations on the punch. This punch press method proves very satisfactory since it is quick, clean and dependable. The former method of molding these nuts from a paste composition is greatly excelled by this process, since perfect work is the general rule, which was an exception in the other case.

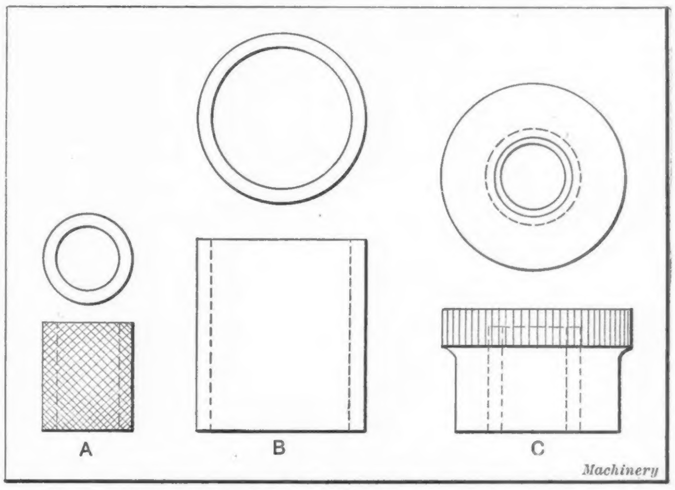


Fig. 2. Blanks and Finished Binding Post made from them in the Molding Die

Beverly, Mass. EVERETT CHIPMAN

SETTING DIAMONDS

In the article by C. L. L. in the July issue of MACHINERY on setting diamonds, it is stated that the use of molten spelter is the usual method of fixing the diamond in place in the end of the rod or tool. Is it? In my contact with grinding operations during ten years past, I have never noticed this to be a particularly common method.

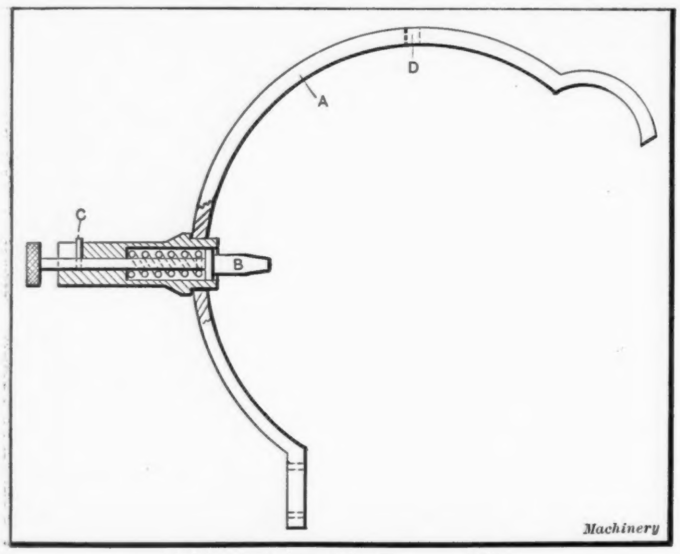
In our shop we use hundreds of diamonds, and also retail many diamond tools. Those that we sell are mounted in soft steel, the metal being peened carefully around the stone. Those that we use ourselves are mounted in copper rods, and we believe this to be the best method, as it is easy to peen the copper around the stone without liability of knocking the stone. The only reason we use the steel instead of copper in filling customers' orders is because they like the looks of the steel better.

The rods in which we mount these diamonds are made of soft machinery steel. We take the diamond and ascertain its approximate diameter at its thickest part by passing it through a drill gage. We then drill a hole in the end of the rod just a little deeper than the length of the stone to be set and of the same diameter as the greatest thickness of the diamond. We then peen the metal carefully around the stone, this being done with the metal cold. The peening is done with a small flat headed chisel or set. If this is done carefully there is no liability of breaking the diamond. When through peening, the diamond is covered entirely by the metal and we then touch the end of the rod slightly to the face of a grinding wheel, removing just enough metal so that but a fraction of the surface of the diamond is exposed.

I can see no necessity of using molten spelter in fixing diamonds in place. GRINDING WHEEL MANUFACTURER

DIVIDING ATTACHMENT FOR A LATHE

The dividing attachment for a lathe shown in the accompanying illustration was designed by the writer for locating quartered keyways in shafting, pulleys, etc. This attachment is screwed into a tapped hole at the front of the gear-guard *A* and the pin *B* enters the space between the gear teeth. A stop-pin *C* limits the amount that pin *B* is forced out, and disengages it when not in use. This stop-pin should not reach the bottom of the slot when the pin is in engagement with the gear, as it is required to have the pin wedged between the teeth to index accurately. A sight hole *D* is drilled at the top of the gear-guard, and in locating quartered work the mechanic



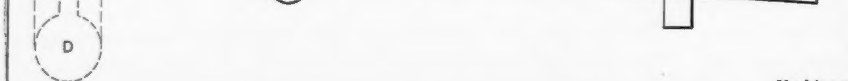
Dividing Attachment for Use on a Lathe

turns the lathe by hand, counting the teeth as they pass under the sight hole. The writer uses this attachment on an 80-tooth gear so that he counts 20 teeth in indexing through 90 degrees. This arrangement could be used for indexing any number of spaces that can be evenly divided into the number of teeth on the gear. In cases where the attachment is constantly used for a given operation, it would probably be a good idea to mark the teeth in some way so that the possibility of making a mistake in counting would be eliminated.

Denver, Col. STANLEY EDWARDS

DEVICE FOR GRINDING HALF BALL JOINTS

The general arrangement of a device for grinding half ball joints is shown in the accompanying illustration. This is a very convenient tool for use in connection with an air motor for grinding hemispherical surfaces, and is particularly adaptable for use in railroad shops. The ends of the arms *A* are



Device used for grinding Half Ball Joints

made to suit the particular class of work for which the tool is intended and they receive either the grinding element or the piece which is to be ground, as the case may be.

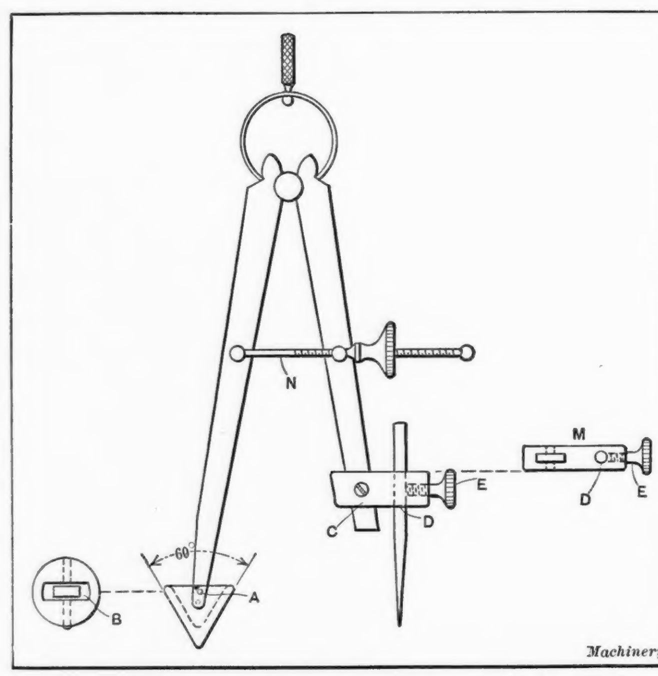
For the benefit of those who are not familiar with operations of this kind, it may be mentioned that these joints consist of two hemispherical surfaces, one piece being of brass and the other of cast iron. The cast-iron piece is finished to the required shape, and the brass part is roughed out and then finished by rotating it against the cast-iron surface which it is to fit, a grinding mixture of oil and emery being used.

The ends of levers *A* may be used to carry either the grinding element or the part to be ground. The part *B* is used to provide a rapid adjustment of the arms *A*, this adjustment being completed by turning the handwheel *C*, to secure the required grip for the arms. The light dotted lines indicate an ordinary handwheel of the type used on valves. This handwheel provides for operating the tool by hand, but where an air motor is available this wheel may easily be removed and replaced by power drive. The method used in some shops for grinding joints of this kind is exceedingly crude and the application of the present tool affords a means of greatly reducing the cost of production. LEROY SMITH

Olean, N. Y.

COMPASS FOR MACHINE WORK

Mechanics often wish to locate points, draw circles, etc., after they have drilled 60-degree centers for turning. This cannot be done accurately with an ordinary compass, and as a



Pair of Dividers adapted for use as a Compass for Machine Work

result the tool shown in the accompanying illustration was designed. About one inch was cut off from the leg of a pair of dividers and the end rounded, after which the hole *A* was drilled. A piece of round steel about ½ inch in diameter was next turned to a 60-degree taper, and a slot *B* cut in the center of this piece to receive the end of the leg without binding. A hole was then drilled through the tapered piece and a small screw used to secure it to the leg of the dividers through the hole *A*.

A piece of metal *M* about 1¼ inch by ¼ inch by ½ inch in size was then prepared. This piece was slotted ⅛ inch from the end, the slot being cut at an angle of about 15 degrees to receive the leg *C* of the dividers. A transverse hole was then drilled and tapped through this slot, and the block fastened to the dividers by means of a screw shown at *C*. A hole *D*, ⅛ inch in diameter, was next drilled through the opposite end of the block at a distance of about ¼ inch from the end. A hole *E* was drilled in from the end of the block and tapped to receive a set-screw. A piece of pointed steel ⅛ inch in diameter and about 2 inches in length was inserted in the hole *D*. The point can thus be secured in any desired position by means of the set-screw. The other settings of the dividers are obtained in the usual way.

With the aid of this tool, it is possible to draw circles no matter how large the hole is in which the fixed leg is located. If it is desired to use the tool in other than 60-degree holes, a suitable taper center could be made for this purpose. The same tool could also be used on more than one taper by making a set of centers to meet the requirements of all such classes of work.

Storrs, Conn. C. M. PFENING

MARKING ECCENTRIC PISTON RINGS

While passing through the factory some time ago, I noticed a mechanic working at his bench on which there was a surface plate with several hundred eccentric piston rings piled up beside it. As I watched him, he picked up a ring, set it carefully up on the plate before him, as shown in Fig. 1, and after trying several times, succeeded in balancing it with

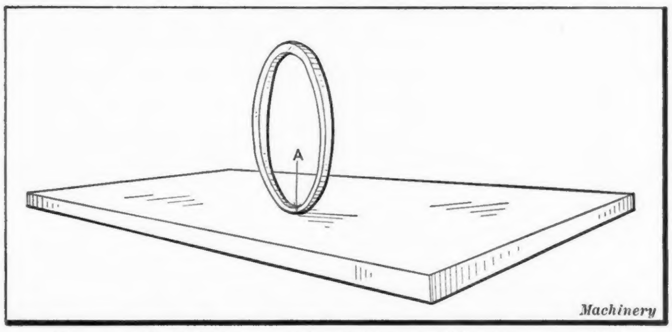


Fig. 1. Old Method of marking Point at which Rings are split

the thin side down. He then scribed a line on the ring at the point *A*. Reaching for another ring he repeated the process, and as I was somewhat curious, I asked him what he was doing. He answered that he was marking the thinnest part of the rings so that they could be afterward split at this point.

This naturally struck me as a somewhat crude process and upon looking up the man's rate, I found that he was getting 30 cents an hour and that he frequently spent from two to three hours a day (depending upon the ring production) in making these little marks on the rings. Obviously this was an expensive operation.

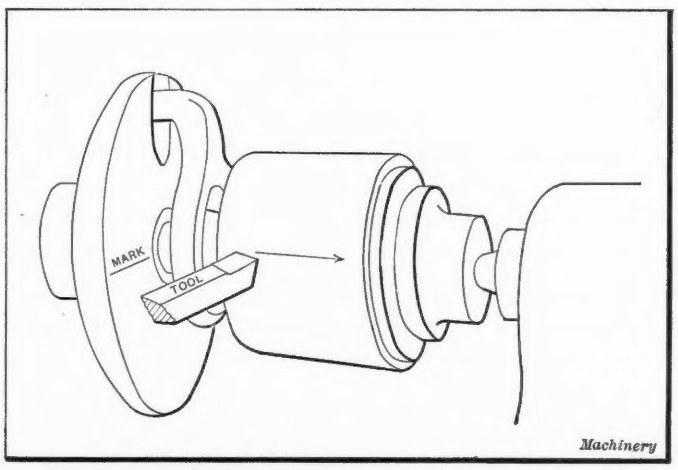


Fig. 2. Improved Method of turning and marking Twenty Rings at One Setting

In order to improve this method I looked up the operation of turning these rings and found that they were put on an arbor with an expanding split bushing (the arbor being eccentric), and turned on an ordinary engine lathe. See Fig. 2. The rings were made in a shell containing material enough for twenty rings, the shell being cut up after it was turned to the required shape. After determining the high point on the eccentric arbor, I made a scratch mark on the faceplate of the lathe at that point. Then, after the rings had been turned and the lathe stopped, and before removing the arbor from the lathe centers, I took hold of the belt and pulled it around by hand until the scratch mark was in line with the cutting edge of the tool. Setting the tool lightly up against the ring shell, I simply ran the carriage along, dragging the tool, and thus marked all the twenty rings at once.

Bridgeport, Conn. ALBERT A. DOWD

MANUFACTURING COMMUTATOR NUTS ON THE TURRET LATHE

Of the various methods used for the manufacture of shallow nuts of large diameter, the following has been found most economical in labor and material. An example of the nuts under consideration is illustrated at *F* in Fig. 1. These nuts are turned on the periphery, bored, chamfered, threaded to gage, and faced true on one side. They are ordered in lots of fifty pieces. The nuts are manufactured from mild steel of a diameter suitable for the work in hand, the stock being cut from the bar in lengths which are approximately equal to twice the diameter. A No. 3-A Warner & Swasey turret lathe is used and the stock is held in the fifteen-inch scroll chuck. A plan view showing the stock in position, together with chuck, saddle turret and tools, is shown in Fig. 1.

After the stock has been chucked as shown in the illustration, turning tool *B* is revolved into position and the

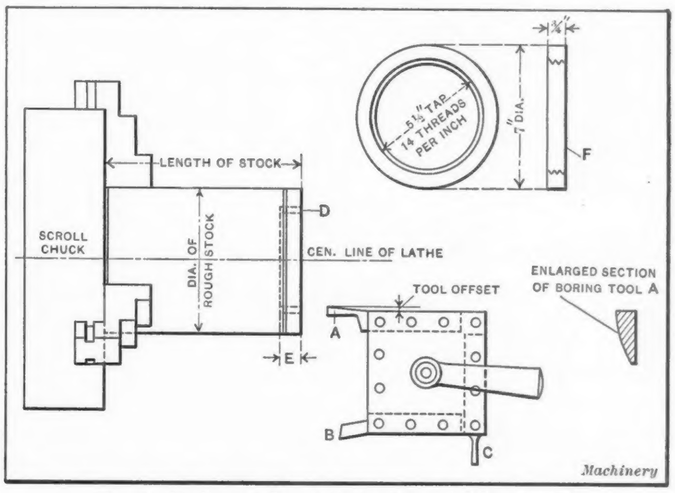


Fig. 1. Tooling of Turret Lathe for machining the Blanks

stock reduced to the outside diameter of the required nut by two cuts. These cuts are taken along the stock as far as the chuck jaws will permit. Boring tool *A* is next fed into the stock face, cutting a groove *D* whose external diameter is suitable for reboring to the tapping size, the depth of the groove being made equal to the thickness of the nut plus one-quarter of an inch. This depth is shown at *E*. After boring tool *A* has been withdrawn, the parting tool *C*, which is ⅛ inch thick, is brought into position and fed into the work to cut off the ring. In a similar manner, boring and cutting off operations are conducted along the stock until the chuck jaws interfere. After the rings are cut off and removed they are piled up ready for the next operation. The stock remaining in the lathe must now be reversed in the chuck, as shown in Fig. 2, the large diameter turned to size, and the rings bored and parted, as in the previous operation. Fig. 2 shows the stock after the first ring has been removed and the second ring cut off. Ring No. 3 may now be cut off by the boring tool, after which the center core of the stock may

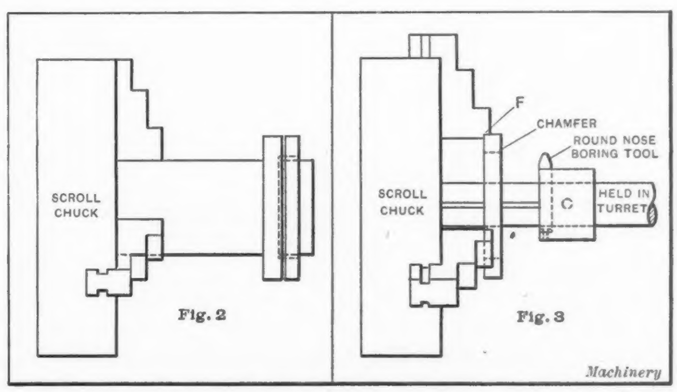


Fig. 2. Bar reversed in Chuck Fig. 3. Tooling for boring Nut Blanks

be removed. This core will be used for nuts of a smaller outside diameter.

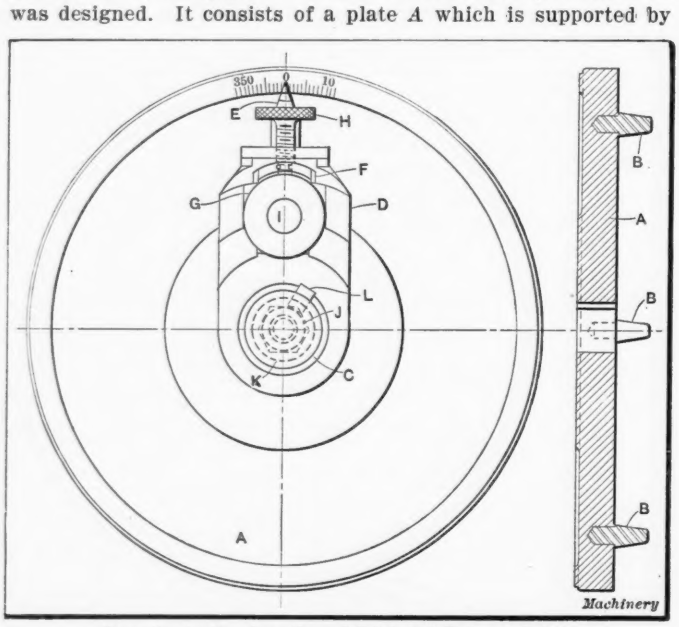
The rings are now ready for boring to the tapping size, facing, chamfering and tapping. These operations are carried out as follows: The ring is held in the chuck jaws, which have been counterbored as shown at *F* in Fig. 3. It is then simultaneously bored, faced, chamfered and filed, this latter operation being necessary in order to remove the sharp burrs from the outer edge of the ring. Boring is performed by the round nosed tool shown in the boring head on the 2-inch arbor which is held in the turret and guided in the lathe mandrel. Facing and chamfering are carried out by tool *B* shown in Fig. 1. The turret is now run back and indexed to bring the collapsible tap into line. This tap (not shown in the illustration) is held in the turret and fed into the work by hand while the work revolves at a slow speed. After the tap is well advanced in its cut, the speed is increased and it runs through the nut at an increased rate. The tap is now collapsed by hand and the tap and turret are run back rapidly. All cutting is carried on under a stream of cutting compound.

By following the above methods, the following advantages are secured. First: there is small expense in preparing the stock, the only machining necessary in this connection being to cut off. Second: forging is entirely eliminated. Third: the cores may be used for smaller nuts, and in this way the waste of material is reduced to a minimum. Finally, the machining operations are simple, rapid and partly simultaneous.

Wilkinsburg, Pa. T. PILKINGTON

GAGE FOR TESTING OIL ENGINE CAMS

The gage illustrated herewith is used for testing the accuracy of cams used for opening and closing the valves of oil engines. These cams are ground to size after being casehardened, but in order to be certain that they are of the exact form that is required to open and close the valves at the required points, the gage shown in the accompanying illustration was designed. It consists of a plate *A* which is supported by

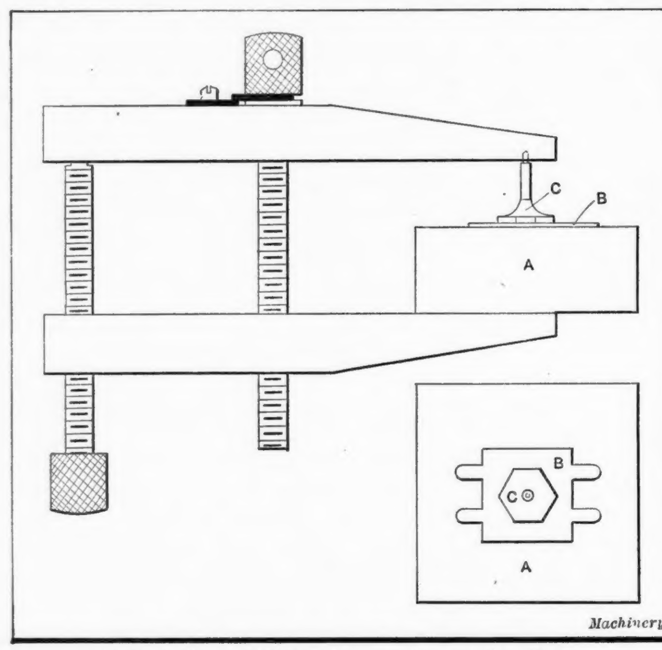


Gage for testing Location of Inlet and Exhaust Points on Oil Engine Cams

four legs *B*. A stud *C* is held in place at the center of the plate by means of the nut *J* and washer *K*, the stud being prevented from turning by means of a small key. The edge of the plate *A* is graduated from zero to 360 degrees, and as the arm *D* is rotated about the stud *C*, the pointer *E* at the end of this arm swings over the graduated scale. The roller *G* is mounted upon the pin *I* and the latter can be adjusted along the slide *F* by means of the knurled screw *H*. In using the gage, the cam to be tested is mounted upon the stud *C*; the bore of the cam is of such a size that it is a slip-fit on the stud *C* and the cam is held stationary in the position which it would occupy on the cam shaft of the engine by means of the key *L*. The roller *G* is now brought into contact with the face of the cam and as the body *D* is revolved, the pointer *E* swings over the graduated scale and shows the exact position of the points of inlet and exhaust. If there is any error in the location of this point on the cam its exact amount is determined by the scale on the gage. M. W. W.

ATTACHMENT FOR PARALLEL CLAMPS

An attachment which the writer has found very handy in connection with the use of parallel clamps on die work is shown in the accompanying illustration. Here it will be seen that a die block *A* has a templet *B* secured to it. *C* is the attachment referred to and serves the purpose of providing the required clearance for scribing all the way round the templet. The part *C* is made from a cap-screw which is ma-



Parallel Clamp Attachment for laying out Die Work

chined to the shape shown in the illustration and then casehardened. The jaw of the clamp on which the attachment is to be used is annealed and has a hole drilled in it to receive the pointed end of *C* which is 1/64 inch smaller than the hole in the clamp into which it fits. The size of the attachment will, of course, be governed by the class of work for which it is intended.

Detroit, Mich. J. F. THOLL

MAKING SMALL ECCENTRICS IN A LATHE

Most machine shops are called upon to handle jobs requiring eccentric turning in a lathe, and the writer was much interested in reading Mr. Donald A. Hampson's description of a simple and inexpensive method of handling operations of this kind, which will be found satisfactory for small quantities of work. An objectionable feature of the usual methods of handling such operations lies in the fact that it is necessary to go to the expense of building special tools even where quantities as small as 100 pieces are to be produced. It is evident that where very accurate work is required, a method which requires chucking a piece twice will introduce an error considerably greater than would be the case where the better known method of using a movable toolpost operated by an eccentric ring on the spindle nose is used. This is not intended to be a criticism of Mr. Hampson's article, as he made it clear that a limit of tolerance of 0.007 inch was allowed on the work produced by his method.

Some shops only consider the item of first tool cost and make use of the movable cross-slide method. In such shops a supply of rings having eccentricities of the various dimensions which are required are carried in stock. An important advantage of Mr. Hampson's method is the saving which would be effected by being able to use ½-inch stock, whereas, by the cross-slide method it would be necessary to make the piece from stock 13/16 inch in diameter. This additional cost of

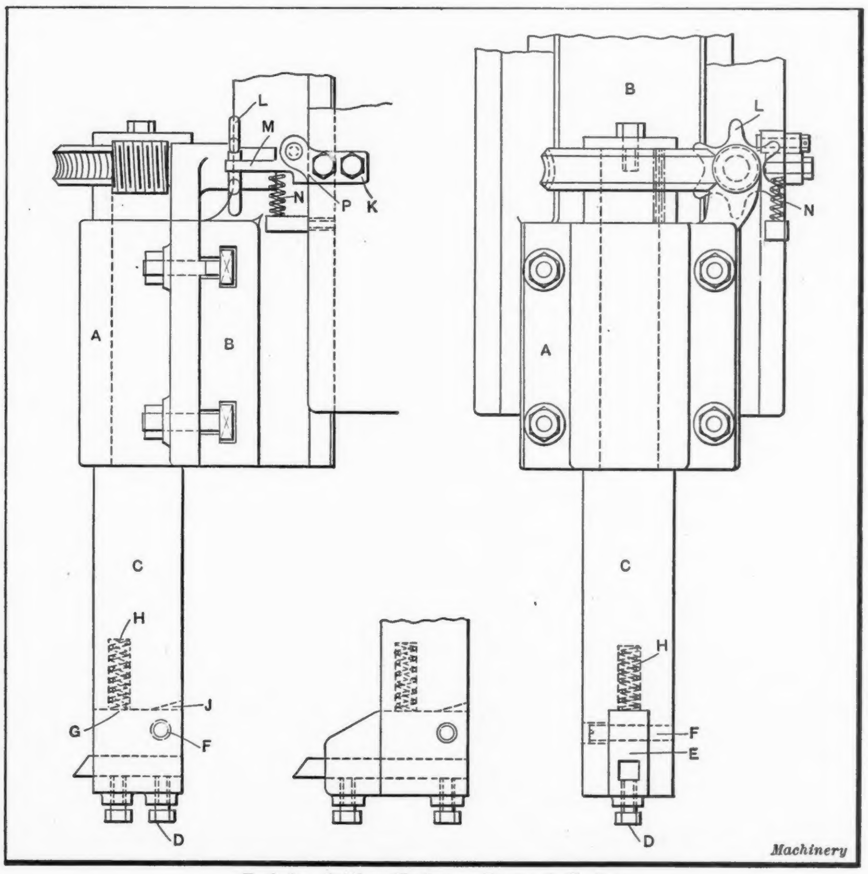
stock could only be justified in cases where exceptional accuracy is required.

The writer has seen parts of the kind described in Mr. Hampson's article manufactured with fairly good results in a drill press, but, of course, such a method requires two operations and also the expense of building a jig. A variety of such work has been successfully handled in a turret lathe by removing the liner or gib and offsetting the turret carriage the required amount to produce the desired eccentricity. A high-speed drilling attachment was made use of to drive a hollow mill for use in turning the stem while the head of the work was formed by a cross-slide tool. In this case the work was made of brass and the amount of eccentricity was quite small.

KARL KLINE

ROTARY TOOL-HOLDER FOR A SLOTTING MACHINE

The illustration shows a simple form of automatic tool-holder which adapts a slotting machine for slotting out circles or parts of circles. This tool-holder will be seen to consist of a bracket *A* which is bolted to the ram *B* of the slotting machine, the bolts used for this purpose being secured in the T-grooves provided for fastening an ordinary tool-holder to the ram. The bar *C* passes through bracket *A* and this bar carries the tool-holder at its lower end. A worm and worm-wheel which transmit the circular movement to the bar are carried at its upper end. The two screws *D* fasten the tool to



Tool for slotting Circles or Parts of Circles

the tool-holder *E* which has a pin *F* passing through it, screwed into bar *C*. When the ram descends, the tool-holder *E* is pressed against the lower face of the bar at *G* and forces the spring *H* into the hole in the bar. After the working stroke has been completed and the ram starts to ascend, the pressure is released and spring *H* forces the tool-holder to swivel on the pin *F* until it is stopped by the inclined surface *J* at the lower end of the bar. This clears the tool from the work and serves the double purpose of preventing the work from being damaged and increasing the life of the tool.

The tappet catch *M* is fastened to the main casting of the slotting machine. When the ram descends, carrying the tool-holder with it, and just before the cutter starts work, the star-wheel *L* on the end of the worm-shaft engages with the tappet catch *M* and is turned through part of a revolution, thus rotating the tool and cutting out a circle or part of a circle as may be desired. The tappet consists of two pieces, a bracket *K* fastened to the frame of the machine, and the hinged piece *M*. As the ram ascends, the hinged tappet is swiveled out of the way when the star-wheel strikes it; but on the downward stroke, just before the cutting begins, the star-wheel engages the tappet *M*, which has been pulled back into position by the spring *N*. The tappet is now held by contact against the surface *P*, so that the star-wheel is turned and transmits the circular movement to the tool through the worm and worm-wheel.

The bar shown in the illustration has a tool-holder of the same diameter as bar *C*, and only comparatively small circles can be cut by this tool. A detailed view of the lower end of a bar is shown, however, equipped with a larger sized tool-holder, and with this tool larger sized circles can be slotted. For circles of smaller diameter, smaller sized bars could be used, having the top part of the proper size to fit the bracket *A* and the worm-wheel. If long bars are used to enable the tool-holder to machine deep holes, they could probably be steadied by bracing them from the ram of the machine.

W. R. O.

KNURLED NUTS

The letter on knurled nuts by Mr. Felix Heberlein, published in the April issue of MACHINERY, reveals a condition in machine building which is of more importance than the first consideration of the subject would lead one to believe. It will be noticed that wherever it is possible to use a standard nut for making adjustments on machines, a hexagon nut is used, but in other places where a special stud or threaded part is made use of, the nut will be knurled instead of being milled to provide for the use of a wrench. This is particularly the case when such a nut is used entirely for purposes of adjustment and is not depended upon for clamping a part in place. The reason for this is that knurling is a much cheaper operation than milling the flats for a wrench. It should be remembered, however, that these knurled parts are not as easily adjusted after the machine has been in use for some time, on account of the tendency for the knurling to become gummed up with dirt and grit. In some cases, a hole is drilled through a knurled nut to provide for the use of a nail or wire to turn it when the fingers are not strong enough for this purpose, and this provision should always be made on the better classes of machinery. Sometimes the adjusting nuts are both milled and knurled so that either a wrench or the fingers can be used to turn them.

In many cases, the designer does not intend a wrench to be used because the parts are tightened too firmly by such a method. On such parts as drill jigs or milling fixtures, the use of a wrench would require too much time for making adjustments. Knurled nuts are hard on the operator's hands and many drill jigs and other tools have the nuts wrapped with tape after they have been in use a short time. For this reason, cast-iron knobs provided with finger holds are superior for use in tool work.

FLANGE

GIVING THE SHOP MAN A CHANCE

A great many articles have been published in the technical papers dealing with the manual training and trade schools which are maintained in conjunction with manufacturing establishments. Manufacturers' associations have devoted large sums of money for the purpose of educating the future generation of mechanics, foremen, etc., but they seem to have overlooked the possibility of doing something for the present generation. If it is a good investment to devote time and money to training young men to become competent mechanics,

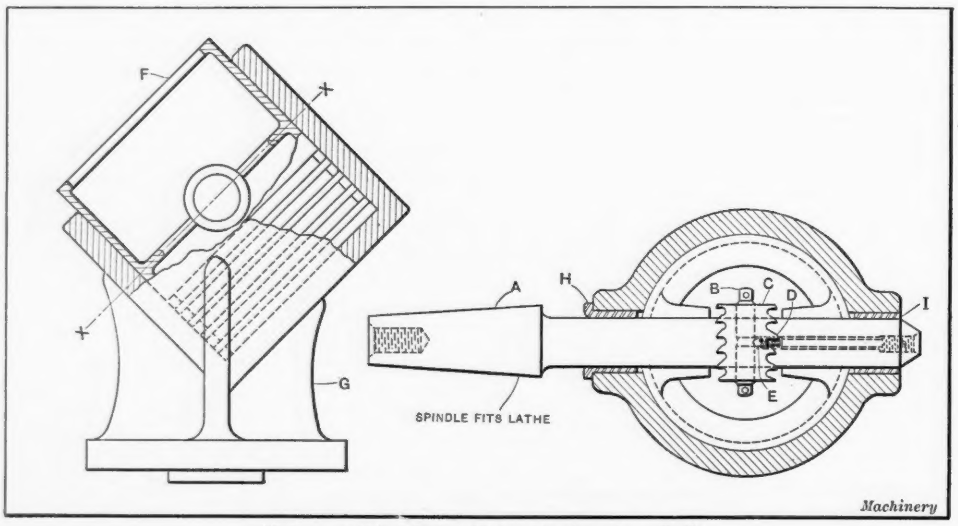
why not do something for the present employes of the shops who learned their trade before the technical schools had been placed in operation? Although such men are admitted to free evening trade schools in the larger cities, a man with a family cannot devote four nights a week to attending school. Furthermore, these classes are largely attended by students to whom it is necessary to explain matters with which the older mechanics are thoroughly conversant.

It appears to the writer that one solution of this difficulty would be to establish a small library of technical books in the factory and provide a reading room for the use of all classes of employes. The men could use this room during the noon hour and possibly for an hour after quitting time. It seems that the provision of books and technical magazines in such a room would offer an opportunity for those men who are interested in their trade to keep in touch with up-to-date methods. Such a library could also be used as a reference room by the various departments.

Newark, N. J. GEORGE W. JAGER

FIXTURE FOR FACING PISTON BEARINGS

The illustration shows a fixture for facing the bearings of automobile pistons. This job is generally handled on a drill press, but the use of the fixture illustrated herewith enables twice as much work to be turned out in a given time by handling this operation on a lathe. The base of the fixture *G* is fitted to the seat of the compound rest and held in place by the rest bolts. A chamber is bored out in the fixture to receive the piston which is about 0.005 inch larger than the piston diameter, so that the work will drop into place easily. The bushings *H* and *I* are ground to the same size as the hole in the piston, and the arbor *A* is 0.002 inch under size. The cutter *C* should be an easy fit on the arbor. This cutter is held by the pin *B* which fits in a hole drilled through the center of the arbor. This hole is a little over size and the pin is held in place by means of the spring *D* and ball *E*.



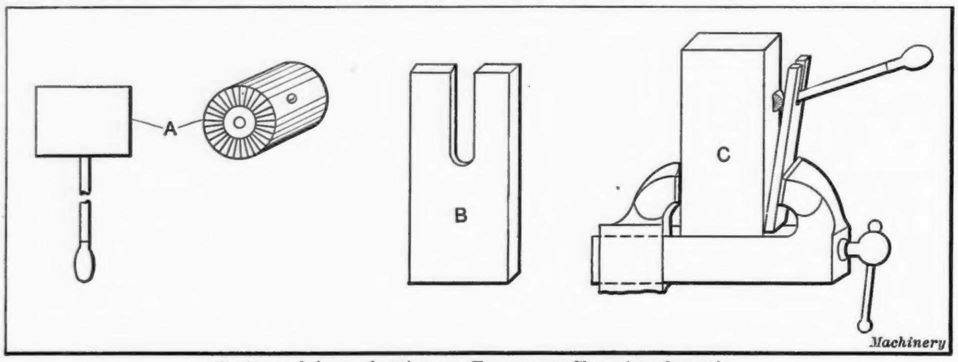
Fixture used for facing Piston Bearings in a Lathe

In using the fixture a stop is placed on the lathe bed at the forward end of the carriage and a second movable stop is placed at the tailstock end. These stops are set to check the feed of the work to the cutter *C* when the two bearings on the piston have been machined the required distance. After these stops have been properly set, it is merely necessary to move the carriage forward and back; by so doing the cutter is brought up against the faces of the two bearings and machines them. The pin which holds the spring *D* and ball *E* against the pin *B* is then drawn back. This allows the pin *B* to drop out and the work can then be withdrawn from the arbor ready to have a fresh casting mounted in the fixture.

Buffalo, N. Y. A. W. MASSECAR

A CHERRYING OPERATION

In most of the articles describing methods used to produce dies and similar tools, it is assumed that the workman has the proper machines at his command for performing the various operations, as it would obviously be impracticable to consider the equipment of each separate shop. However, an "all around" mechanic should be versatile and ingenious enough to get out a special job at times, even when he has not, as often happens, the proper machine tools at his command.



Tools used in performing an Emergency Cherrying Operation

The following describes a "cherrying" operation on a drop-forging die which the writer recently performed by hand. It was required to sink a number of impressions, half cylindrical in shape, and approximately 15/16 inch in diameter by 1 inch long, into the face of a drop-forging die block. This is a difficult impression to "sink," although it can easily be done by means of a special fixture on a milling machine. In this instance, however, there was no milling machine available, nor was it desired to spend very much money on special tools. A tool-steel cutter *A* was turned to size in a lathe, and the teeth were formed by moving the lathe carriage back and forth by hand. A piece long enough to make several of these cutters can be made in this way, and the cutters can then be cut from the bar to the length desired. The teeth on the ends of the cutters were made with a cold-chisel. A 3/8-inch hole was drilled part way through the middle of the cutter, to provide a place for inserting a handle of drill rod by means of which the cutter is rotated. The cutter was then hardened and drawn to a light straw color.

The piece *B* was then made of 1/2 by 2-inch tool steel. This was used to press the cutter against the work, the handle projecting through the slot in one end of the piece. After drilling and chipping out the greater part of the stock, the cutter was inserted as shown at *C* and the impression filed by revolving the "circular file" back and forth by means of the handle, the pressure on the cutter being regulated by tightening the vise. While this may seem a rather crude way to those who are fully equipped for this kind of work, it was rapid and efficient and produced the desired result with a very small outlay for equipment.

HENRY J. BECK

Troy, Ohio.

BENDING DIES FOR CAR FORGINGS

The following methods are employed in a railroad forge shop for bending certain forgings which are used on passenger and freight cars. Fig. 1 shows an equalizer *A* which is used on passenger cars; it is made from a square billet of steel forged to the shape shown at *B* on a pair of flat dies. The bending is done by means of the pair of dies *C* which weigh about two tons. There are two pairs of bending surfaces, one

for each end of the equalizer; the full and dotted lines show the equalizer in position between these bending surfaces. The tapered surface at *D* is for tapering the body of the forging. The flat surface of the die is provided for flattening the equalizer between the blows which are applied in the forming and bending operations. The work is all done under a 4000-pound steam hammer. The bearing surfaces *E* on the equalizer are machined after the forging operation is completed and the equalizer is then ready to be assembled on the car truck.

The forging shown at *A* in Fig. 2 is known as a suspension spring and the tools *B*, *C* and *D* are used for forming it to the required shape. The eye end of this forging is slotted on a punch press and the small hole is then punched at the

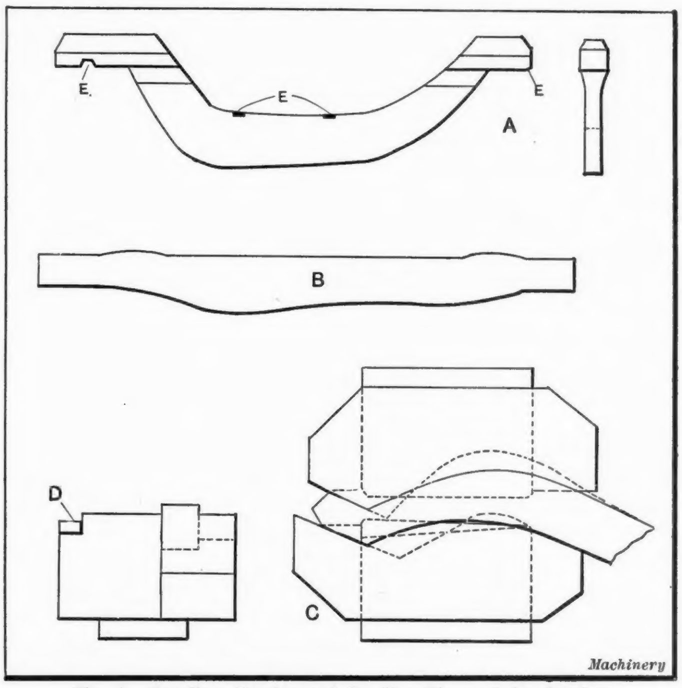


Fig. 1. Equalizer Forging and Bending Die used for forming

opposite end. The tools *B* and *C* are used for the two operations involved in forming the eye, these tools being mounted on a bulldozer. The opposite end of the spring is bent to the required form by hand. In performing this operation, the end of the work is placed in the slot and held in position by the pin *P* which fits into the hole that was punched in this end of the stock; the work is then bent to shape around the form

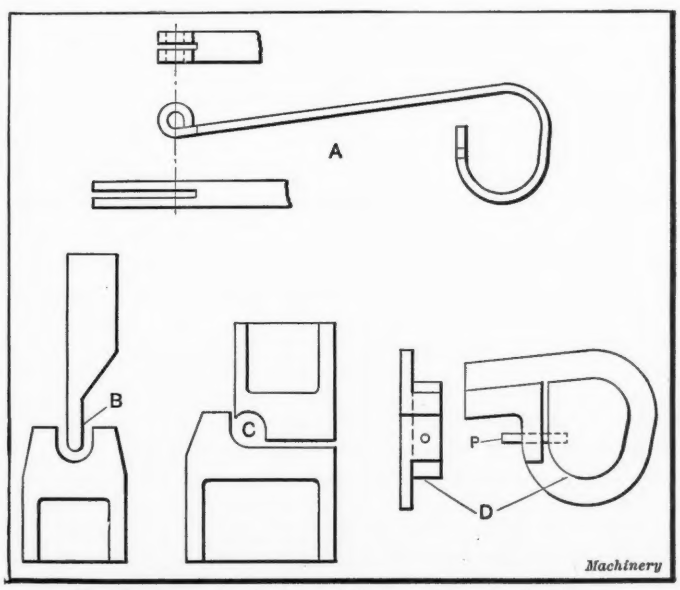


Fig. 2. Suspension Spring and Tools used for bending Ends

D. A flattener and small sledge are used to forge the spring to shape around the form.

Fig. 3 shows a special design of freight car step *A* and the tools *C* and *D* which are used to form these steps on a bulldozer. The holes are first punched in the stock and the two bends *V* are produced by means of the tool *C*; the tool *D* is then used to produce the two bends *W*, a U-fork being placed over the stock and its ends inserted in the hole *H* in order to keep the work from drawing in either direction. The ends of the step are then twisted at *T*, the step being placed edgewise between the two pins on a large faceplate and a U-fork used

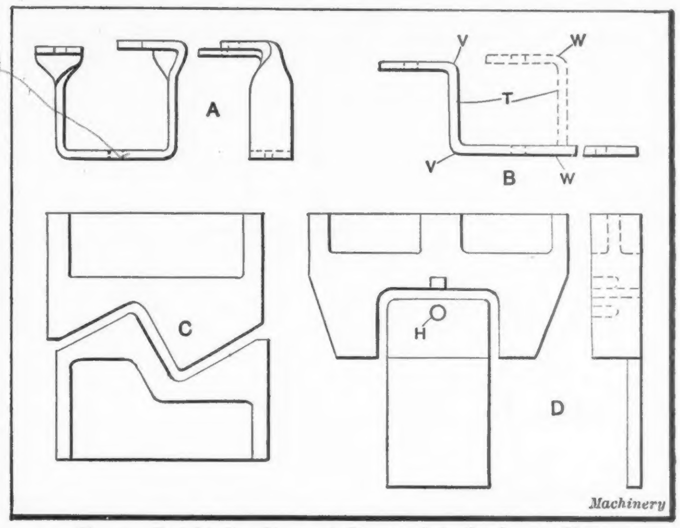


Fig. 3. Freight Car Step and Dies used in forging to Shape

for twisting the work to the desired shape. A single heat suffices for all of these forming operations.

Fig. 4 shows another form of freight car step *A* which is formed by means of the tools *B* and *C*. In making these steps, the ends of the stock are first heated and twisted on a faceplate; the plates *D*, one on the die below the stock and one on the other die above it, keep the flat stock from buckling. After the ends have been twisted and bent by tools *B*, the forging is heated at the center and the round bend and angles *a* are formed by tool *C*. The slant of the step is pro-

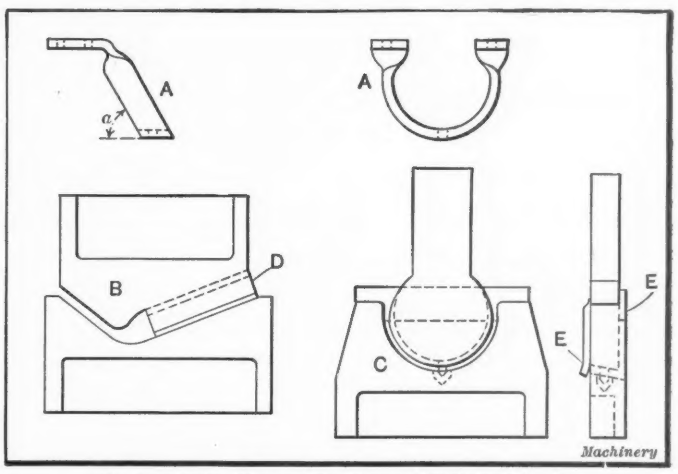


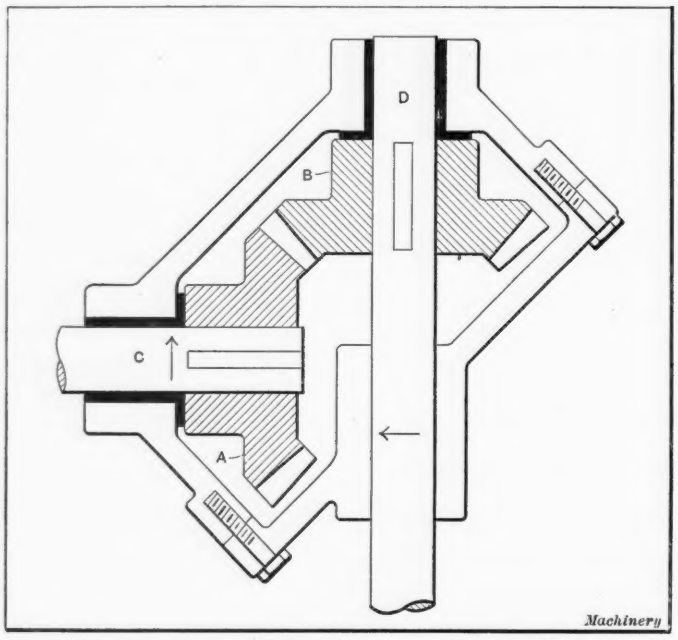
Fig. 4. Another Form of Car Step and Method of forming

vided for by having the working surfaces of the dies at the required angle with the sides. The plates *E* keep the stock in position during the bending operation and a pin which passes through the hole in the center of the step keeps the stock from drawing in either direction. S. E. M.

BEVEL-GEAR DRIVE FOR SHAFTS RUNNING IN THE SAME DIRECTION

The bevel-gear drive described in the June issue of MACHINERY by Mr. Francis W. Clough seems to be an ingenious piece of mechanism, but I fail to see the necessity for the third gear. If Mr. Clough had arranged his drive as shown in the accompanying illustration the shafts *C* and *D* would rotate exactly as shown in the illustration accompanying his article. The gears *A* and *B* shown in the accompanying illustration are miter gears and may be obtained from stock in various sizes, while the angle of the pitch cone of Mr. Clough's gears *A* and *B* is slightly less than 45 degrees and two gears of this kind could not be obtained from stock without buying two other gears that would be useless.

Furthermore, I cannot agree with Mr. Clough when he says "A valuable feature of this drive is the possibility of locating one horizontal shaft above or below another. Thus the advantage of a skew bevel gear can be obtained by means of this combination." If by this Mr. Clough means that he can use bevel gears of the usual type where skew bevel gears would ordinarily be called for I think he is mistaken; as in his design the center line of the stud *G* must intersect the center



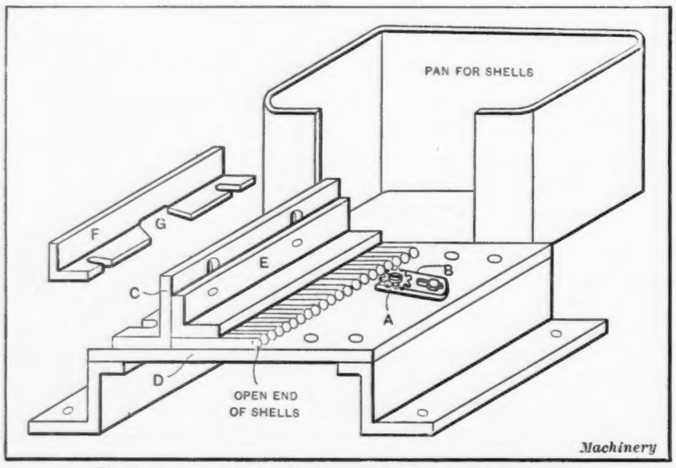
Bevel-gear Drive where Both Shafts run in the Same Direction

lines of both of the shafts *C* and *D* and it would be impossible to fulfill this condition if the shafts *C* and *D* were in different planes.

Brooklyn, N. Y. WALTER GRIBBEN

FEED MECHANISM FOR DRAWING BRASS SHELLS

In order to economically feed brass shells that are to be operated upon by a punch and die, we are making use of a gravity-feed arrangement somewhat similar to the one described in the May issue of MACHINERY under the title "A Punch and Die for Forming Electric Terminals." The only trouble that we have had with this device has been due to letting a shell go down the chute with the closed end toward the punch instead of the open end. In such a case, the shell buckles, which almost invariably results in breaking the punch.



Mechanism used to feed Brass Shells to a Drawing Press

This involves a loss of time to stop the machine and replace the broken punch, in addition to the actual cost of the punch.

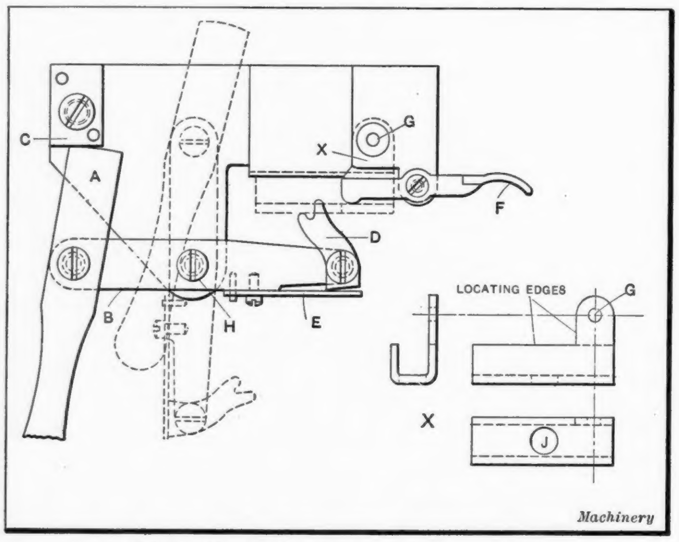
The accompanying illustration shows an attachment which we have applied to this feed mechanism to make it absolutely "fool proof." It will be seen that a small toothed disk *A* is mounted on a stud carried by the part *B* mounted on the body of the feed mechanism. As the shells pass down the chute, the teeth on the disk enter into their open ends, the disk revolving to allow the shells to pass. If a shell is put into the chute with the closed end out, the tooth of the disk which comes into contact with it is not given sufficient clearance to enable the disk to revolve. Consequently, the shell cannot pass down the chute and result in damage to the punch and die.

This arrangement is simple in construction and operates efficiently. Referring again to the illustration, it will be seen that adjustment is provided to adapt the feed mechanism for different diameters and lengths of shells. The bracket *C* is fastened to the body *D* by means of two 3/8-inch cap-screws. The guide *E* can be raised or lowered to accommodate shells of various diameters; this guide prevents the shells from rolling over one another. The guide *F* is illustrated separately in order to show the construction of this part. It is held to the body by means of two 3/8-inch cap-screws, and the slot *G* provides ample room for the toothed disk to engage with the shells as they slide down the chute. In order to obtain the best results, the distance between centers of the teeth of the disk *A* should be the same as the distance between the centers of adjacent shells. It will be seen that a pan is provided in which a supply of shells is held ready to be fed into the chute.

G. H. T.

QUICK-ACTION CLAMPING DEVICE

A binding device of novel design that is applicable for use on a variety of dies and jigs, if modified to suit the requirements of different cases, is shown holding the sheet-metal part *X* which is also shown in detail. This piece is secured to the die to have the small hole *G* pierced in it. It will be seen from the illustration that the lever *B* has a cam *A* at one



Quick-action Binding Device for Dies and Jigs

end and a finger *D* at the other. This lever swings about the center *H*, and is shown by dotted lines swung away from the die to allow the work to be removed. After swinging the clamping device out of the way, the work is kicked off the die by the ejector *F*. A new piece of work is next placed in position and the operator pulls the cam lever *A* over to bring the cam into engagement with block *C*; he then pushes the lever to the right to clamp the work in position. The flat spring *E* presses against the finger *D* and throws it forward on its center so that when it first engages the work, the shorter extension gradually slides toward the left until the longer extension comes into contact with the edge of the hole *J*. The work is moved to the left in this manner until the lug in which the hole is being pierced engages with the shoulder on the die and further action of the lever pushes the work firmly against the side of the die. In this position, the work is located ready to be punched. The arrangement of the levers is such that ample pressure can be secured to hold the work in position on the die.

Hartford, Conn. S. VICTOR BROOK

SPEED RATIOS OF AUTOMOBILE PLANETARY GEARS

In replying to the inquiry of G. M. G. concerning speed ratios of planetary gears in the February issue, I submit a solution which is simple and does not require the use of any complicated mathematical formulas. Taking the different gears in the same order, and using the same letters of reference mentioned by G. M. G., I will commence by clutching the drum G to prevent it from moving. As long as the drum remains stationary, the gears D, C, B and A take the form of a simple train, the speed ratio of which is:

$$\frac{20}{25} \times \frac{15}{30} = \frac{2}{5}$$

or, to state it more simply, wheel D makes 5 revolutions while wheel A makes 2 revolutions.

When the clutch J is engaged it is obvious that the whole piece of mechanism becomes locked to shaft K, owing to the wheel D being keyed to K, and wheel F being caused to rotate at the same speed as K by the action of clutch J. This results in the whole mechanism revolving in the same direction and at the same speed as the driving shaft K.

By clutching the drum H, the wheel F becomes fixed and the drum G which carries the planetary gears must revolve either in one direction or the other. Looking at the apparatus from the clutch end, let us assume that drum G makes one revolution in a clockwise direction, and that the wheel F remains stationary. It is now necessary to find the speed and direction of rotation of the wheel D. We will proceed in the following manner. Throwing clutch J out of action, imagine the whole apparatus to make one revolution in a clockwise direction, where it will be clear that each wheel has made one complete revolution about the common axis K. Tabulate these revolutions—as shown in Table I—calling movement in a clockwise direction positive and in a counter-clockwise direction negative. Now wheel F should not rotate, being a fixed wheel, and as we have given it a clockwise revolution we must correct this by keeping drum G fixed and revolve wheel F one revolution in a counter-clockwise direction. This will impart motion to wheels E, C, and D, as tabulated in the second line of Table I. We have now fulfilled the conditions of the first half of gear G, making one revolution in the clockwise direction and F remaining fixed. The effect on the other wheels is obtained by taking the algebraic sum of the corresponding columns in Table I, where we find that wheel D makes 18/17 revolution in the counter-clockwise direction and one revolution in the clockwise direction.

TABLE I

F	E	C	D	G
$+1$	$+1$	$+1$	$+1$	$+1$
-1	$-\frac{28}{17}$	$+\frac{28}{17}$	$-\frac{28}{17} \times \frac{25}{20} = -\frac{35}{17}$	0
0	$+\frac{45}{17}$	$+\frac{45}{17}$	$-\frac{18}{17}$	$+1$

Machinery

Having found the rotation of wheel D in relation to drum G, we can determine the revolutions made by wheel A, relative to D, in the same time that drum G makes one revolution. Proceeding as before, imagine the whole arrangement to make one revolution in the clockwise direction and tabulate the results as shown in Table II. Now in this case, wheel D makes 18/17 revolution in the counter-clockwise direction, while drum G makes one revolution in the clockwise direction, and to attain this motion in relation to D we must keep drum G fixed and revolve wheel D 35/17 revolution in the counter-clockwise direction. Therefore, by giving this motion to wheel D, it will cause wheels C, B and A to revolve as tabulated in the second line of Table II. The effect on the other wheels is obtained in the same manner as previously explained, and we find that wheel A makes 3/17 revolution in the clockwise direction while wheel D makes 18/17 revolution in the counter-clockwise direction, the ratio being 18:3. In other words, wheel A makes one revolution while wheel D makes six revolutions in the opposite direction. Hence, the three ratios obtainable are:

TABLE II

D	C	B	A	G
$+1$	$+1$	$+1$	$+1$	$+1$
$-\frac{35}{17}$	$+\frac{35}{17} \times \frac{20}{25} = +\frac{28}{17}$	$+\frac{35}{17} \times \frac{20}{25} = +\frac{28}{17}$	$-\frac{28}{17} \times \frac{15}{30} = -\frac{14}{17}$	0
$-\frac{18}{17}$	$+\frac{45}{17}$	$+\frac{45}{17}$	$+\frac{3}{17}$	$+1$

Machinery

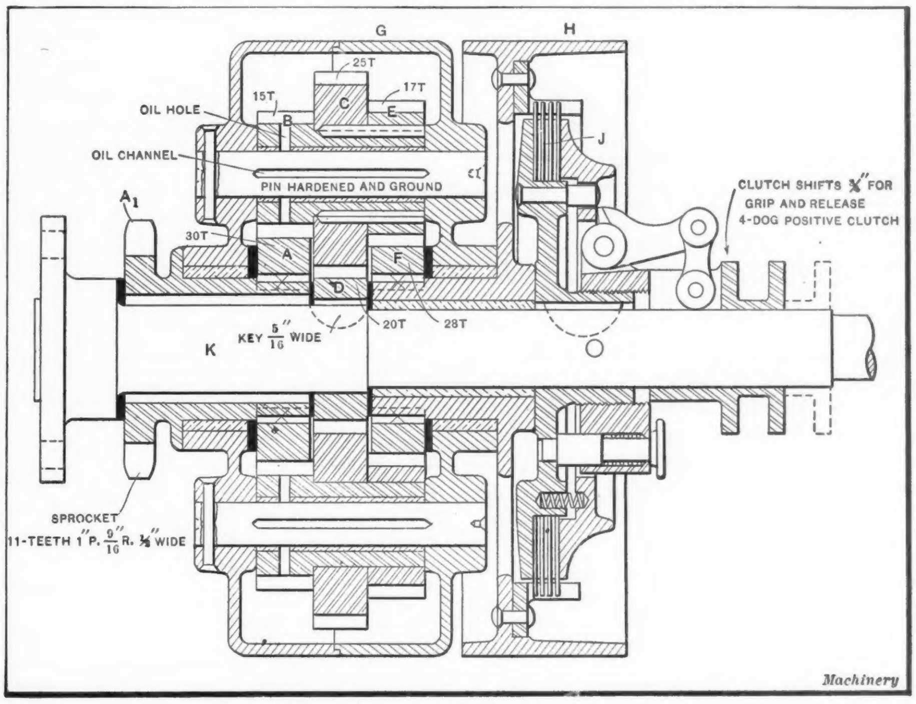


Diagram showing Automobile Planetary Gear

First case	1 : 0.4	or 5 : 2
Second case	1 : 1	or 1 : 1
Third case	1 : 0.166	or 6 : 1

H. A. P.

[Correct solutions of this problem were also obtained from Mr. Otto M. Hoch, 69 Kirkland Road, Rochester, N. Y., and from Mr. M. Owen, 20 Railway Road, Manchester, England. —EDITOR.]

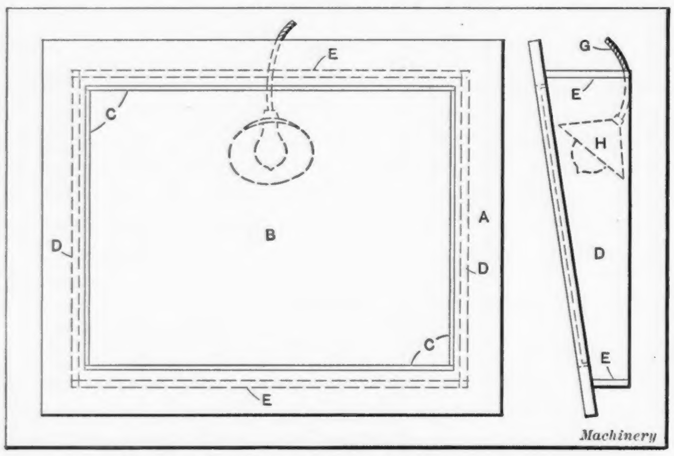
SHADOWLESS DRAWING BOARD

The accompanying illustration shows a small shadowless drawing board which may be used for a number of purposes in the drafting-room. Such a board is inexpensive to make and will take the place of boards of this kind that are sold in the market at a price which is usually prohibitive for small drafting-rooms.

Referring to the illustration, the construction of this drawing board may be briefly outlined as follows: The frame is made of soft wood and fits around a square piece of ordinary glass B. This glass is held flush with the surface of the board A by means of small wooden strips C. The side and end boards D and E are made of soft wood, a notch being provided at the center of the back board E for the lamp cord G to pass through. By placing a tungsten lamp with a reflector H under the board, a very good light may be obtained through the glass, and this illumination may be made still better by placing a

sheet of white paper on the table under the board. The dimensions may be made suitable for the class of work which is to be handled and the design may be further improved by using more than one lamp.

The writer has found a board of this kind useful for numerous purposes, among which the following may be mentioned: Reverse drawings may be conveniently made for parts which are to be made right- and left-hand but similar in other respects. This is done by simply turning the drawing for the left-hand part over and tracing a drawing for the right-hand part from the reverse side of the paper. This practice saves

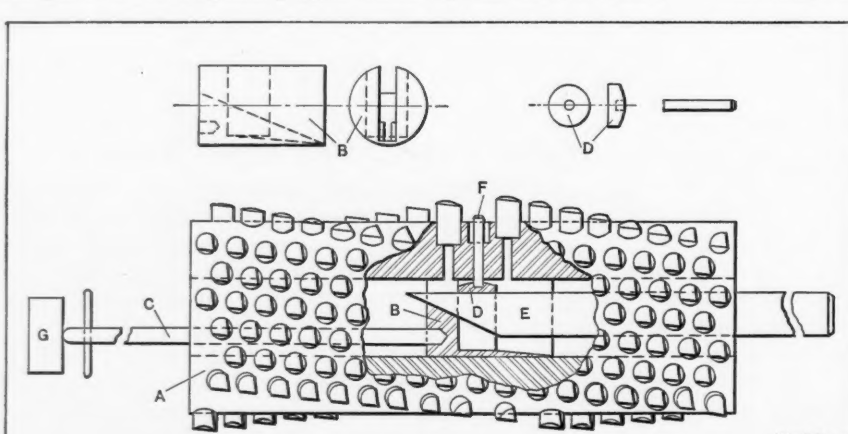


Plan and End View of Shadowless Drawing Board

a great deal of time which would otherwise be required to make separate drawings for the right- and left-hand parts. Another use for this board has been found in making tracings of drawings on heavy paper where it is impossible to see the lines in the ordinary way. Tracing from blueprints to bristol board can also be handled on a drawing board of this kind. Other uses will be found for the board when it is installed in the drafting-room. R. A. C.

DRIFT FOR DRIVING WORN TEETH OUT OF A CUTTER

Shops that use the type of inserted-tooth milling cutter shown in the illustration will find the use of a drift for driving out worn teeth the means of making a considerable saving in the cost of their tools. In most cases, it is customary to throw away these cutters after the teeth have become worn, but the use of this drift enables the old teeth to be driven out and new ones to be inserted in their place. Referring to the illustration, the design of this drift may be briefly outlined as follows: The body of the milling cutter is shown at *A*, and the cylindrical piece *B* is a sliding fit in the bore of the cutter. This piece *B* is moved in the bore of the cutter by means of the handle *C*. The cylindrical guide plug *D* fits in the hole in the piece *B*. This guide plug is raised by the drift *E* which



Drift used for driving Worn Teeth out of an Inserted-tooth Cutter

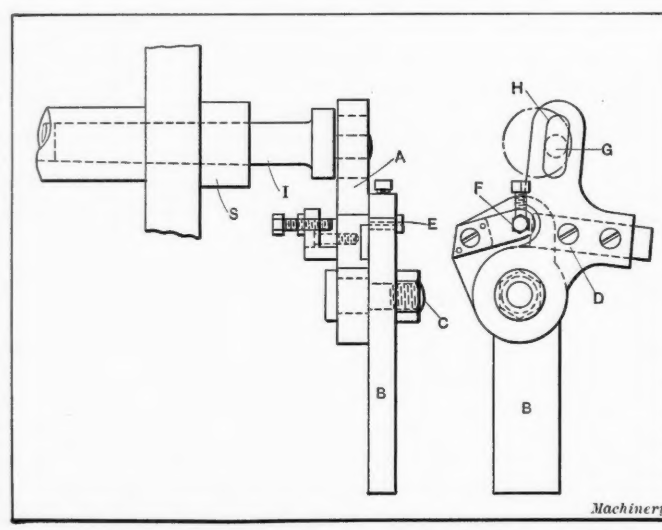
enters the slot in *B* and forces the ejector pin *F* up into the hole in the body *A* of the cutter. By this means, the ejector pin is brought against the bottom of the tooth of the cutter and drives it out, so that a new one can be inserted.

It will be seen that the end of the handle *C* is backed up by a support *G* when the drift is in use. This prevents any lateral movement that would result in shearing off the ejector pin *F*. Referring to the detail of part *B*, it will be seen that there is a narrow slot in the bottom of the slot which receives the drift *E*. This narrow slot receives a smaller key which enters the point of the ejector pin in the hole beneath the cutter. The handle *C* and this key are manipulated by hand until the pin has been entered into a hole; the key is then forced into the slot and the taper drives the pin up until it comes into contact with the bottom of the cutter. As the pin *F* is a tight fit in the hole, it will remain in this position. The key is then withdrawn and the drift *E* driven in to force the worn cutter out of the body. A new cutter can then be inserted in its place. The use of two keys is only required where the wall of the cutter is thick, making a considerable vertical movement of the ejector pin necessary.

Lansing, Mich. AUGUST KORBUS

PIN CUTTING FIXTURE

Small pins and rivets of either brass or soft steel are not economically produced on an automatic screw machine when the required diameter is obtained from the bar. A more economical method consists of cutting off blanks to the required length, and in a plant where large quantities of soft steel pins are used the fixture shown in the accompanying illustration



Bench Lathe Fixture for cutting Brass or Soft Steel Pins or Rivets

was designed for this purpose. It is not necessary to cut off the blanks with great accuracy, as they are subsequently finished to the required length after being assembled in position.

Referring to the illustration it will be seen that the method is one of "chopping off" the blanks from the bar stock, this being accomplished by the swinging arm *A* which is pivoted to the holder *B* by means of the shoulder stud *C*. The cutting tool *D* is carried on the arm *A*, and it will be seen from the illustration that this cutter passes over the inside end of the guide bushing *E* through which the rod is fed against the adjustable stop *F*. A reciprocating action is imparted to the swinging arm *A* by means of the eccentric pin *G* which operates in the elongated slot *H* in the center *I*. The drive is obtained from the lathe or milling machine spindle *S*.

In use, this fixture was set up on a speed lathe and operated by a boy who was able to produce 6000 pins per hour at an hourly rate of only twenty cents for labor. Those readers of MACHINERY who have a similar problem to handle can rest assured of the convenience, efficiency and economy of this method.

Hartford, Conn. CHARLES F. SCRIBNER

FIXTURE FOR MILLING BINDER BUSHINGS

Fig. 2 shows a binder bushing on which it was required to mill the arc *A* and the fixture shown in Figs. 1 and 4 was designed for this purpose. These bushings were first turned and drilled on a turret lathe and were then cut off to such a length that the pieces were 3/16 inch longer than two finished bushings. After completing these operations five of the bushing blanks are mounted in the fixture, where they are securely held by the clamp *H* which is secured by means of the screw *K*. The fixture is mounted on the milling machine table so that the center of the stud *D* is in line with the center of the slitting cutter *F*. The table is then locked transversely, as no cross movement is necessary. The upper part of the

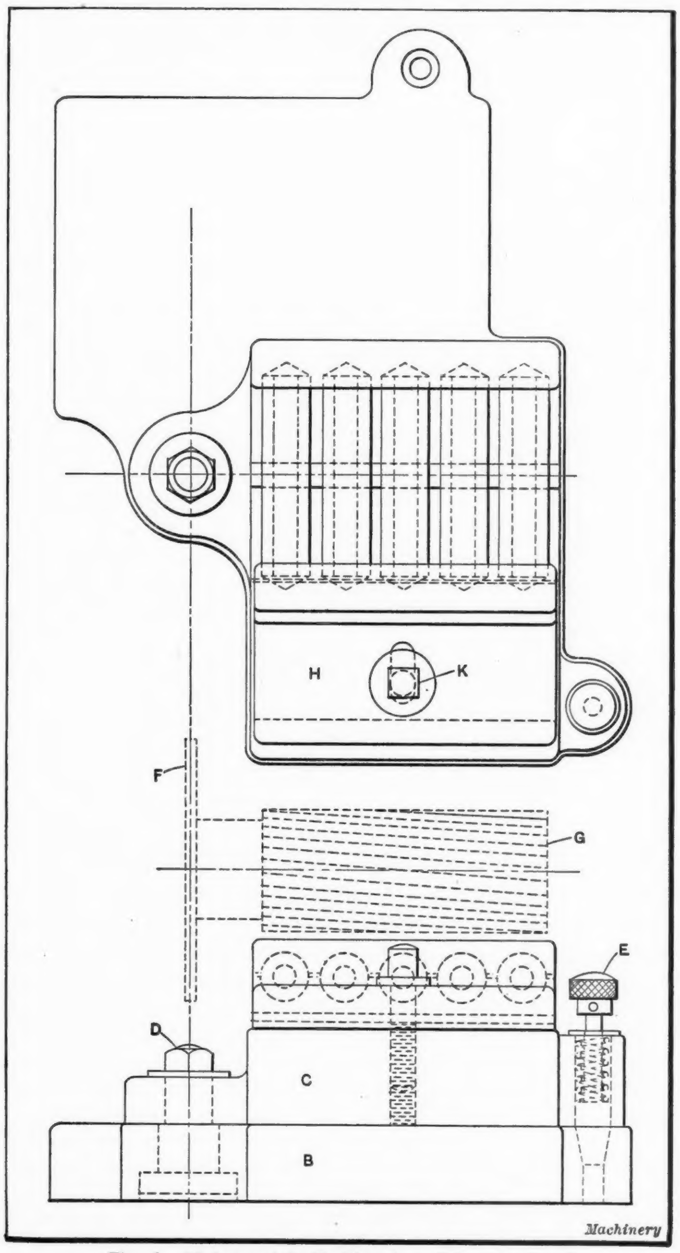


Fig. 1. Fixture set in Position for milling the Arc A in Ten Bushings

fixture *C* is pivoted on the stud *D* which is carried by the base *B* of the fixture. Two operations are performed on this fixture; the first consists of milling the arc *A* on ten bushings, and the second of slitting the five blanks mounted in the fixture so that they form ten complete bushings. In performing these two operations, it is necessary to swing the fixture through an angle of 90 degrees, so that the work can be brought into position under the slitting cutter *F* after the milling cutter *G* has completed its work. The taper spring pin *E* is used to locate the work in the required position for either operation.

Fig. 1 shows the fixture set up for milling the arc *A*. A stop located in the vertical T-slot of the machine prevents the work from being fed too far in against the cutter, thus gaging the depth to which the arc *A* is milled. The work is centered under the cutter by means of a stop shown in detail in Fig. 3; this stop is located in the small T-slot on the side of the table. The stop is adjusted so that the cutter will be

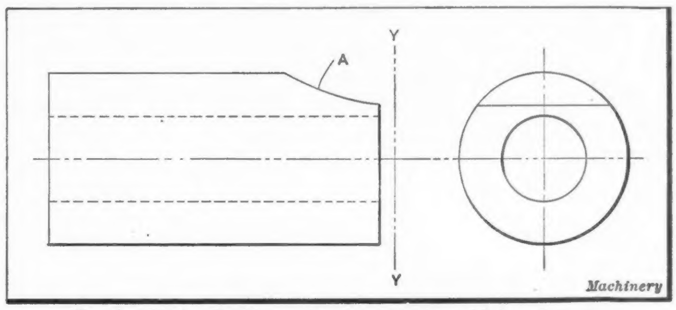


Fig. 2. Binder Bushing with Arc A to be milled and to be cut off on Line Y-Y

exactly in the center of the bushing when the swinging arm *M* engages the swivel block *N* of the miller. After the arc has been milled the arm *M* is lifted out of the way, as shown at the right-hand side in Fig. 3, so that the table is free to move in either direction. The fixture is then swung through

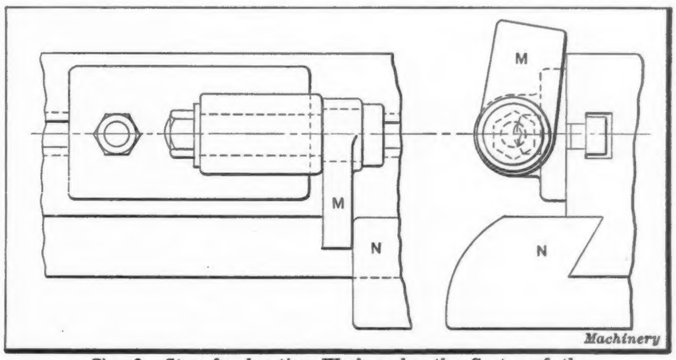


Fig. 3. Stop for locating Work under the Center of the Milling Cutter G

an angle of 90 degrees and re-locates the work under the slitting cutter *F*. The work is then fed up against this cutter and the five pieces clamped in the fixture are cut apart so that ten complete bushings are produced. L. J.

COLORING BRASS IRIDESCENT COLORS

Brass on copper can be given an iridescent color somewhat similar to that produced on steel when the temper is drawn by immersing the articles in a bath. To prepare the solution, dissolve 3 parts of soda hyposulphite and 1 part lead acetate in 48 parts of water. Plunge the pieces into this solution and

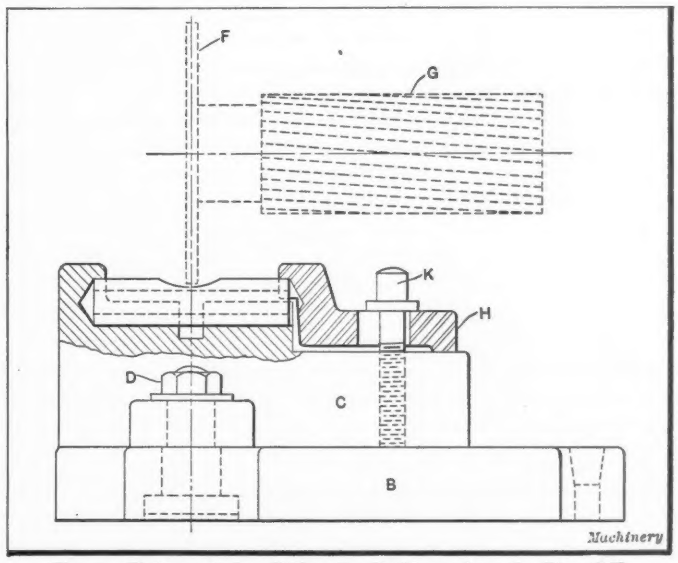
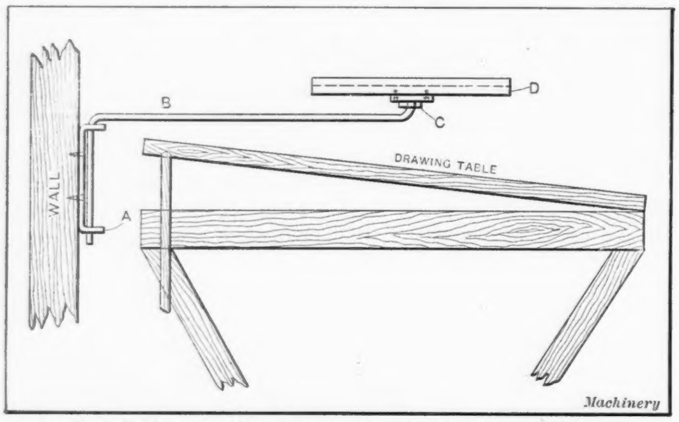


Fig. 4. Fixture set for slitting the Bushings along the Line Y-Y

let them remain for some time. Remove the parts frequently to see when the desired depth of color is reached; then rinse off in water and dry. Unless care is taken in dipping the parts it is a difficult matter to secure the same color on a large part that is obtained on a smaller one. D. T. H.

SWINGING TABLE FOR THE DRAFTING-ROOM

The illustration shows a small swinging table for holding drawing instruments, ink and other small tools. The use of a table of this kind will be found particularly convenient in a drafting-room, as it keeps the tools close at hand and still avoids having them littered over the drawing board. It will be seen from the illustration that the table is supported by an arm *B* which swings in a bracket *A*; this enables the table to be swung to any convenient position. If the drawing



Auxiliary Table for holding Instruments and Ink in the Drafting-room

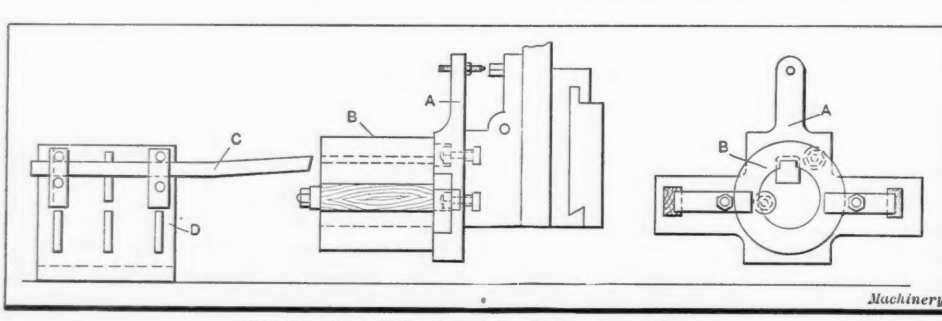
table is not situated close to a wall, the bracket *A* can be secured to the back of the drawing table.

The construction may be briefly explained as follows: The bracket *A* is made of a piece of 1- by 3/8-inch flat steel which is turned up at the ends and drilled to receive the swinging arm *B*. Holes are also drilled in this bracket to receive the screws which secure it to the wall. The arm *B* is made of a piece of 11/16-inch round stock, which is turned down at one end to fit into the bracket *A* and up at the other end to enter the socket *C*. The length of the arm can be varied to suit the conditions in the drafting-room. The socket *C*, which can be made of either hard wood or iron, is screwed in position on the bottom of the table *D*. This socket has a hole drilled in it to receive the upturned end of the arm *B*. The table *D* can be conveniently made of a piece of ½-inch board, sawed out to 12 or 14 inches in diameter and surrounded by a thin strip 1 inch in width to prevent the tools from being knocked off. The entire device can be made very easily, and it will be found a great convenience in the drafting-room.

R. A. C.

KEYSEATING PULLEYS ON A PLANER

In a shop where I worked for some time we had a small planer, but no slotting machine, and so keyseats in pulleys and bushings were cut by hand. Consequently, I looked through MACHINERY and other magazines for a suitable attachment to put on the planer to adapt it for cutting keyseats, but all the devices I came across had the fault of not giving



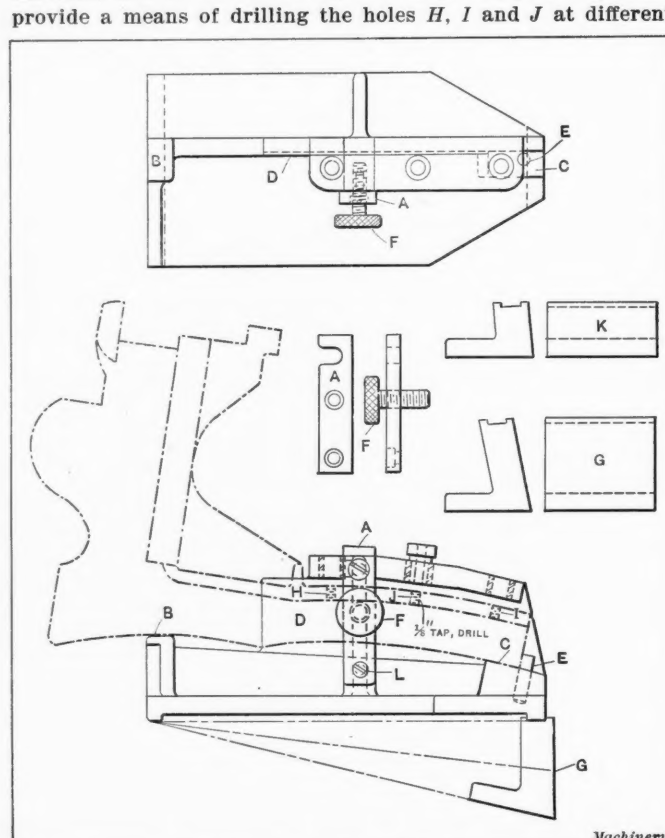
Attachment used for keyseating Pulleys on a Planer

the tool relief on the back stroke. Finally a job came forward which required a keyseat 1 inch wide by ½ inch deep to be cut through cast-iron bushings five inches long. After some study I devised and made the attachment shown in the accompanying illustration. A cast-iron plate *A*, shaped somewhat as shown and planed on both sides, was bolted to the clapper box. There were slots (not shown) in the two side wings for bolts. A bushing *B* is shown in position ready to have the keyseat cut. The tool *C* was bolted to the side of an angle-plate *D* secured to the table of the planer. The set-screw shown on top is to prevent too much swing if the tool should catch on the sides during the return stroke. It is, of course, obvious that the range of both the length and diameter of the work that can be handled in this way is limited.

Christchurch, New Zealand. JOHN PEDDIE

JIG FOR DRILLING AND TAPPING HOLES

The accompanying illustration shows an interesting method of drilling holes at different angles in the curved flange of the piece shown mounted in the jig used for this purpose. The piece in which these holes are to be drilled is part of a textile machine, and it was necessary to design a jig which would provide a means of drilling the holes *H*, *I* and *J* at different



Jig used for drilling Holes at Different Angles

angles. Referring to the illustration, it will be seen that all these holes run to a common center. The first step in the drilling operations consists of mounting the work in the jig. For this purpose, the swinging clamp *A* is swung down out of the way and the work placed upon the supporting points *B* and *C* of the jig, where it is located by means of the back wall *D* and pin *E*. The clamp *A* is then brought back into position and the work secured in the jig by means of the knurled-headed screw *F*. The hole *H* can now be drilled and tapped through the bushing in the jig. After finishing this drilling operation, the right-hand end of the jig is raised and the auxiliary block *G* is placed under it. This brings the work into the correct position for drilling and tapping the hole *I*, it only being necessary to move the jig on the drill press table to bring the bushing under the spindle. After completing this operation, the block *K* is placed under the jig, and this brings the work into the required position for drilling and tapping hole *J*, the operation being performed as in the preceding cases. Detailed views of the two auxiliary blocks and also of the clamp *A* which is used to secure the work in the jig are shown in the illustration. This method affords a very simple way of performing what looked like a rather difficult drilling operation.

M. F.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

WELDING TOOL-STEEL SEGMENTS TO CAST IRON

J. C. F.—How are tool-steel segments prepared for welding to cast iron? I wish to make some castings with tool steel cutters fixed in them, as in a certain make of pipe die.

A.—The process is simple. The steel requires no preliminary treatment except to remove all rust and scale, and very hot iron should be used. The mold should be so gated that the molten iron flows around and past the steel segments and thus heats them up to the fusing temperature before the mold is filled. Under such conditions the steel and iron readily unite, and cool as one solid mass. This method is employed in making steel-faced jaws for machinists' vises and similar shop equipment.

ETCHING ON BRASS

M. R.—We are having considerable trouble in etching the graduation marks on a brass casting which forms part of an apparatus made by our company. The method we are following is to clean the part with gasoline and cover with an asphaltum coating, having first ground and polished the surface. We mark the lines through the asphaltum coating by means of a special engraving machine and etch with a solution of two parts nitric acid and one part water. The graduations are approximately 1/16 inch apart. Our trouble is that the acid seems to work in under the asphaltum coating on each side of the line, resulting in uneven and too wide graduations. We are not sure we are using the right acid for etching, neither are we sure that the coating we are using is the best. Any information you can give to help us out will be appreciated. We are spoiling a large percentage of the parts, working under present conditions.

A.—The question is submitted to the readers for answer. An article on etching steel as well as brass, giving full directions for coating the work and making the etching solution would be appreciated by many readers.

PROBLEM IN GEOMETRY

Inquirer.—In the problem illustrated in Fig. 1, the dimensions 3.8 and 5.1 inches are known, and also the 23-degree angle. How can the diameter of the circle be found?

A.—In order to show the general solution of this problem, the construction lines shown in Fig. 2 are drawn, and dimensions given in symbols; r is the radius of the circle. Angle α and lengths a and b are given. Then:

$$c = a \div \sin\alpha;\quad d = b \div \sin\alpha;\quad e = a \times \cot\alpha.$$

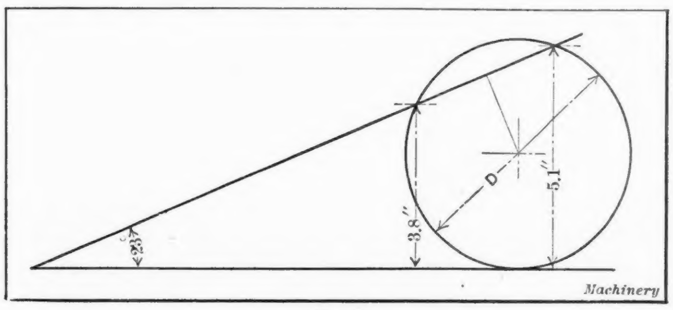


Fig. 1

According to a geometrical proposition, if two lines are drawn to a circle from a point outside of it, so that one of the lines is tangent to the circle and the other line intersects the circle, then the rectangle contained by the total length of the intersecting line and that part of it which is between the outside point and the periphery, equals the square of the tangent; hence:

$$f^2 = cd, \text{ or } f = \sqrt{cd};\ g = f - e;\ h = a - r;\ r^2 = g^2 + h^2 = g^2 + (a - r)^2$$

$$r = \frac{g^2 + a^2}{2a}$$

In the problem given, $\alpha = 23$ degrees; $a = 3.8$; and $b = 5.1$. Then:

$c = 3.8 \div \sin 23° = 9.7261$ inches.

$d = 5.1 \div \sin 23° = 13.0535$ inches.

$e = 3.8 \times \cot 23° = 8.9528$ inches.

$f = \sqrt{9.7261 \times 13.0535} = 11.2675$ inches.

$g = 11.2675 - 8.9528 = 2.3147$ inches.

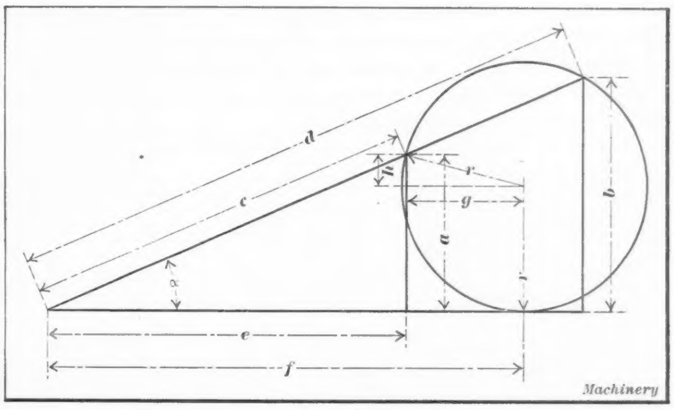


Fig. 2

$$r = \frac{(2.3147)^2 + (3.8)^2}{2 \times 3.8} = 2.605 \text{ inches. Diameter} = 5.210$$ inches.

* * *

"OLD-NEW" INVENTIONS

An interesting article in *Industritidningen Norden* calls attention to some of the early inventions that were the forerunners of many of the modern wonders of engineering. As an example may be mentioned the submarine boat. The statement is made that such a vessel was actually built in 1625 and more or less successfully experimented with on the Thames. About 1710, Emanuel Swedenborg, most generally known, perhaps, on account of his religious writings, but who also was one of the most advanced scientists of his age, published a pamphlet in which he described the construction of a vessel which "can with its whole crew dive beneath the surface of the sea wheresoever it pleaseth, and do great harm to the enemy's fleet."

A flying machine which was invented in Vienna in 1809, by a watchmaker, Degan, had a great many details in common with the aeroplane of today. Records state that Degan actually flew with this machine, and that "he did not only rise and fall but actually navigated in the air." Swedenborg, as early as 1716, made up general plans for a flying machine. He was certain that the power problem, which he was unable to solve, would be solved some time in the future. "There are plenty of proofs and examples in nature," said he, "that flights can be done without risks, although some one at the first experiments must pay for his experience and not be too particular about the loss of an arm or a leg."

The fact was recently established by archeologists that the imperial palace in Rome was provided with elevators some two thousand years ago, although it has not been determined exactly how the power was supplied nor how they were operated.

* * *

A great water power development has just been completed at Keokuk, Iowa, on the Mississippi River. A concrete dam nearly 4300 feet long, 53 feet high, 42 feet thick at the base and 29 feet thick at the top impounds a lake 65 miles long and gives a mean head of about 32 feet. The cost of the dam, power house, turbines, electrical machinery, locks, drydock, etc., was about $27,000,000. The power made available is 300,000 H. P., and will be transmitted to nearby cities and towns and to St. Louis, 144 miles distant. The transmission line to St. Louis will be operated at 110,000 volts. The turbine runners are nearly 40 feet diameter and the scroll chambers were molded in concrete instead of being made of metal. The lock has the same width as the Panama Canal (110 feet) and a lift of 40 feet. The gates weigh 5000 tons.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NORTON PLAIN CYLINDRICAL GRINDING MACHINE

The Norton Grinding Co., Worcester, Mass., has designed and built a heavy cylindrical grinding machine for use in grinding rolls used in rolling sheet steel. The largest rolls which it is expected to grind in the machine are 34 inches in diameter by 18 feet in length, the rolls being supported by massive pillow blocks which hold them by their necks. The machine swings 54 inches in diameter, and when used as a plain cylindrical grinder, it has a capacity of 21 feet between the centers. The machine can be furnished to take any desired length between centers. As will be noted from the illustrations, this machine is equipped especially for grinding heavy rolls, but it can be supplied without this special equipment, then being suitable for grinding plain cylindrical work on centers up to its maximum capacity. The machine is arranged for motor drive only, the equipment being as follows: A 40 H.P. motor mounted on the wheel carriage for the revolution of the grinding wheel and wheel carriage traverse, a 15 H.P. motor mounted on the headstock for work revolution, a 2 H.P. motor on the footstock for traversing the footstock along the ways of the work base, a 2 H.P. motor on the headstock for traversing the headstock along the ways of the work base, and a 2 H.P. vertical motor on the wheel carriage for the pump revolution and traversing the grinding wheel at right angles to the work.

Control

This machine is controlled from one position, the operator standing upon the wheel carriage beside the grinding wheel in such a position that he can look directly down between the face of the grinding wheel and the face of the work which is being ground, and see what is taking place at the point of contact between the grinding wheel and roll. Standing in this position, the operator can reach all of the handwheels and levers necessary for starting and stopping the wheel revolution, starting or stopping the roll revolution, reversing the traversing wheel carriage either by hand or by power, moving the wheel carriage for delicate adjustments by hand, moving the wheel to and from the work either by hand or by power, starting or stopping the traverse of the wheel carriage, changing from maximum to minimum speed of the wheel carriage traverse, and controlling the amount of water or lubricant flowing over the wheel and work.

Referring to Figs. 1 and 6, the operator uses the upper handwheel for feeding the grinding wheel to or from the work, one revolution of this handwheel moving the grinding wheel a distance of 0.040 inch, corresponding to 0.080 inch reduction in the diameter of the work. If the grinding wheel is to be moved by power, the upper handwheel is disengaged by moving the lever at the right of the handwheel toward the operator and locking it in this position. This raises the handwheel, disengaging it from the wheel feed mechanism and at the same time releases the wheel traverse lever at the lower left-hand side. Moving the wheel traverse lever to the right or left operates a clutch, resulting in a movement of the grinding wheel either to or from the work. These levers are so constructed that the power traverse cannot be thrown in until the handwheel has been disengaged; nor can the handwheel be engaged until the power traverse levers have been thrown out of engagement. The lever at the upper left-hand side of the handwheels controls the stopping, starting and reversing of the wheel carriage. When automatic traverse of the wheel carriage is desired, this lever is placed in its lowest position. With the lever in the next higher position the wheel carriage can be reversed or stopped by hand. With the lever in its upper position, it engages the lower handwheel with wheel carriage traverse mechanism, permitting movement of the wheel carriage by hand. The changes in speed of work revolution are accomplished at the headstock by means of change gears. Intermediate speed changes for traverse of the wheel carriage are made on the front of this carriage.

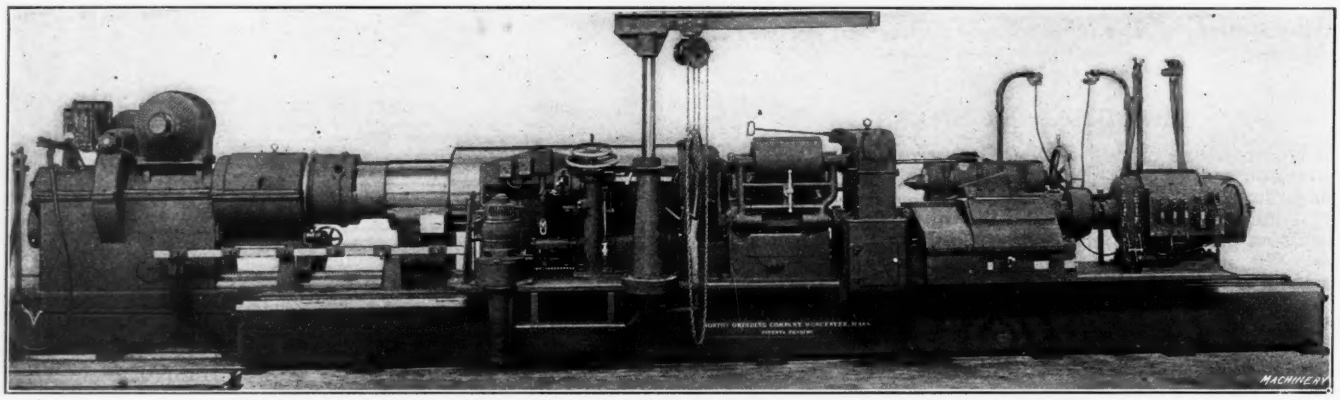


Fig. 1. Front View of Norton Roll Grinding Machine showing Roll in Position for grinding

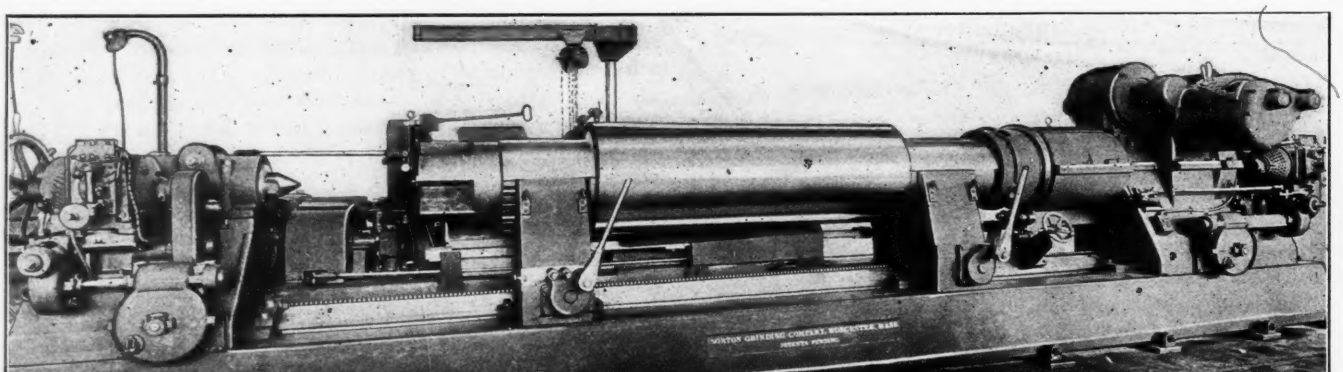


Fig. 2. Rear View of Norton Roll Grinding Machine showing Roll in Position for grinding

Ways and Maintenance of Alignment

As this machine is designed for very large work, it is imperative for the ways in which the wheel carriage travels to be perfectly straight, and to obtain straight ways on this machine the Norton pendulameter is used. This instrument makes sure of the detection of errors as small as 0.001 inch at any point along the ways as related to parallelism and straightness of the ways. The ways are then scraped to master straightedges until the pendulameter registers a perfectly straight line. It will be noted from the illustrations that the machine is provided with supporting wedges which are attached to the base, and the alignment of the ways can be corrected at any time, but the width and length of the bearing of the wheel carriage on the ways of the base are so ample that it is improbable after the machine has once been set up and adjusted for correct alignment, that any error can be detected after many years of use.

Single Wheel Design

Years ago Mr. J. Morton Poole invented the double wheel machine with a swinging frame to secure accurate diameters over the entire length of the roll, because at that time there were no known methods of producing and maintaining straight ways of sufficient accuracy to secure perfectly straight lines or a uniform diameter of roll with a single grinding wheel. The machine here described is designed and constructed in accordance with the experience of recent years, *viz.:* That it is quite practical to produce and maintain ways for a single grinding wheel which will secure absolutely perfect rolls. Incidentally, the advantage of this single wheel is that with the present design it is possible to have the wheel large in diameter, of wide face, and so mounted and provided with a powerful drive that it is possible to grind rolls in a few hours which formerly required a day or more for their grinding. It is also more convenient to place heavy rolls in the machine, or remove them from the machine than when the double wheel machine is used.

Under the old system a roughing cut was unknown. All cuts were practically finishing cuts and hours, in fact days, were spent in the slow process of grinding with small wheels, not exceeding 14 or 15 inches in diameter by 1 or 2 inches in width, and relatively small spindles and frail supports were provided for carrying these wheels. In designing this machine, the two objects in view have been accuracy and large production. The older line of double wheel roll grinding machines have produced accuracy at the expense of time. With the single wheel machine of modern design, advantage can be taken of greater weight and power, securing accuracy and at the same time large production.

Production

The first roll grinding machine of the type described in this article was shipped to a well known steel mill for grinding rolls to be used in the rolling of steel plate. The rolls are of various diameters and lengths, but the largest roll the customer expects to grind on this machine is 34 inches in diameter by 18 feet in length over all, although rolls 54 inches in diameter can be ground if desired. It will be noted by reference to the illustrations, that the machine is equipped with massive pillow blocks and bearings for carrying the rolls upon their necks, the largest of these necks being 24 inches in diameter. During the demonstration of this machine, rolls were ground in from one-fourth to one-half the time previously required for finishing the same rolls in the lathe. As yet there has not been sufficient time in which to definitely establish the conditions under which the machine will give the greatest output, but there is every reason to expect that greater saving will be shown after the machine has been longer in commission.

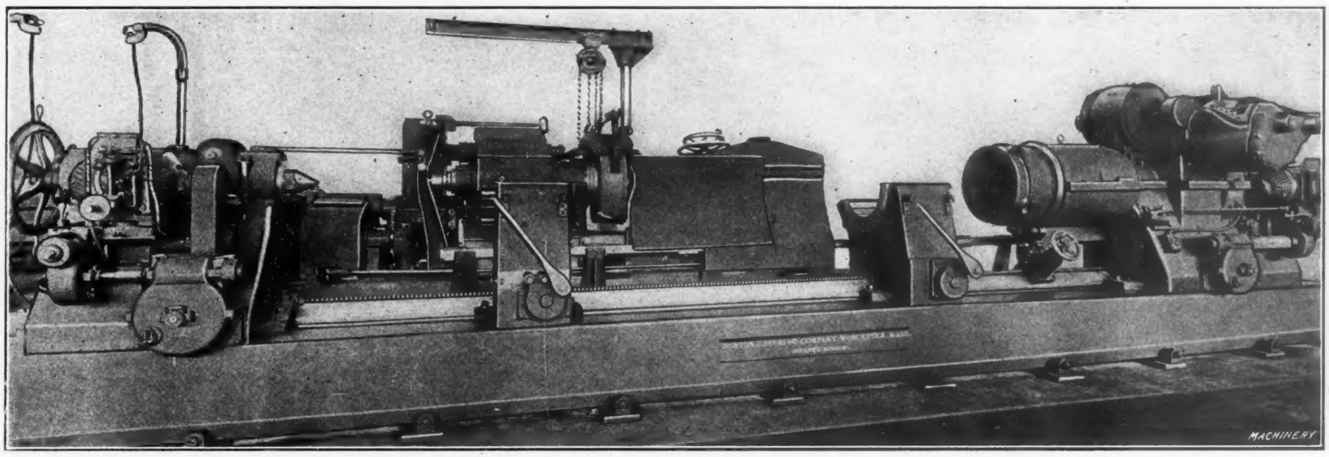


Fig. 3. Rear View of Norton Roll Grinding Machine showing Roll removed from Bearings

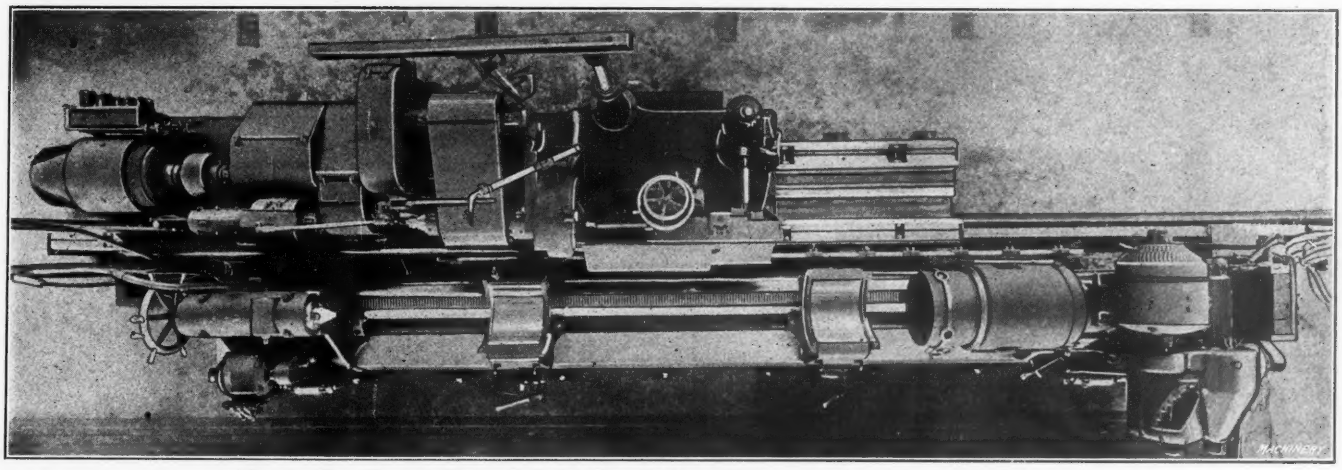


Fig. 4. Plan View of Norton Roll Grinding Machine; Photograph taken from a Traveling Crane

General Description

The original design of Norton plain grinding machines has been departed from in this case, for the reason that the work to be ground is of such size that in order to see the point of contact between the work and the grinding wheel, it is necessary for the operator to have control of the machine on the same side of the work as the wheel is grinding. He does, however, as in the standard machine, have entire control of all of the important functions of the machine while standing in one position, and without reaching over the work. To secure perfectly smooth work, the rolls are revolved through helical

gears and a large worm and worm-wheel running in a bath of oil, six speeds of work revolution being provided. The headstock spindle is 12 inches in diameter, the footstock spindle is 10 inches in diameter, and the centers are 6 inches in diameter and are interchangeable.

When grinding rolls carried on their necks, they are revolved by means of a large universal joint, in order to give a steady and uniform rotation of the work, one end of the universal joint being bolted to the faceplate of the headstock spindle. To the other end is bolted a driving sleeve which clamps solidly to the wabbler end of the roll, revolving as a part of the roll. The driving sleeve and universal joint are made of steel castings. When grinding work on centers, the universal joint, the universal joint case and the driving sleeve are removed and a driver is bolted direct to the faceplate on

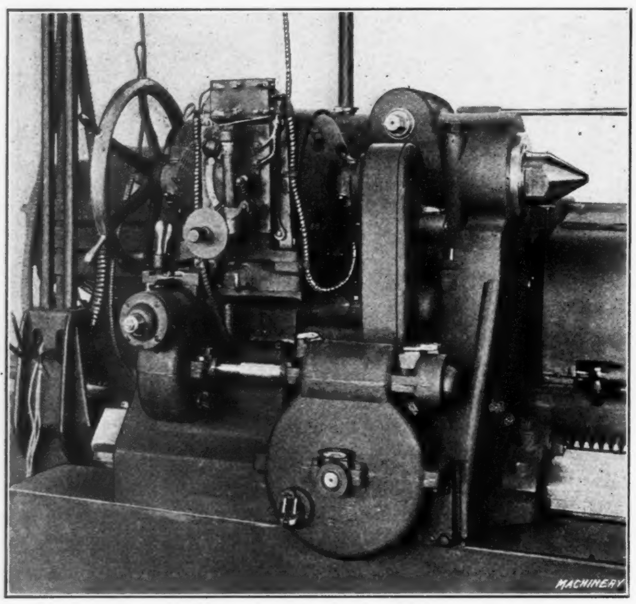


Fig. 5. Detail of Footstock of Norton Roll Grinding Machine

the headstock spindle. The wheel head, with its spindle, wheel guard, wheel sleeve and wheel, weighs over 5000 pounds and rests upon a solid wheel head base mounted on the long, heavy traversing wheel carriage, making it possible to grind the roll rapidly.

Provision is made for grinding the necks of the rolls, either when carried on the machine centers or when the rolls are revolved upon their necks in specially arranged bearings. Machines can be supplied either with or without the footstock, as the footstock is not necessary for grinding the roll necks, it being entirely practicable to grind rolls both on necks and bodies when carried in these specially arranged bearings. The pillow block bearings for use in grinding the necks are arranged with multiple bronze bearings which are adjustable for the small variation in the size of necks. A pillow block is required for each standard size, and an adjustment takes care of the variation from the standard. Perfectly round necks are produced, no matter whether or not there are centers in the roll. A trammel is provided for adjusting the roll neck bearings to correct diameter before the roll is placed in position for grinding, the design of this trammel being shown in Fig. 7. Fillets on the roll necks can be ground with the same wheel and at the same time as the necks are ground. A forming attachment is also furnished, which is adjustable for any radius for forming the corner of the grinding wheel when fillets are to be ground. A truing device is also furnished for truing the face of the grinding wheel, as shown in Fig. 7. The pump delivers about thirty gallons of lubricant per minute to the wheel and work.

The castings forming parts of this machine contain about 20 per cent steel, giving a very close grain casting possessing good wearing qualities. The wheel spindle is of the best chrome nickel vanadium steel, heat-treated to a hardness which gives it extraordinary wearing qualities. The grinding wheel sleeve is a steel casting, as is also the wheel guard, this guard weighing over 600 pounds. The shafts are made of the

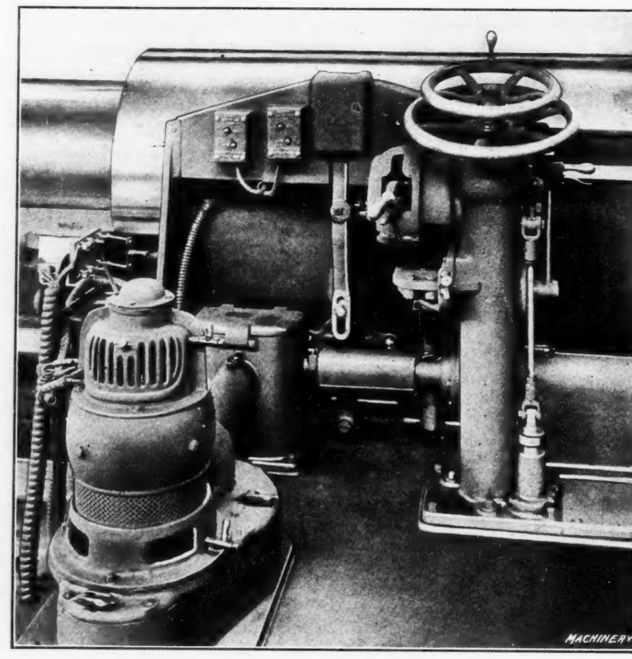


Fig. 6. Detail of Control of Norton Roll Grinding Machine showing Wheels and Levers governing Hand and Power Feed

best carbon steel and carefully ground to size. The worm and worm-wheel are of material well suited for the purpose, and were made by the Brown & Sharpe Mfg. Co. The helical gears in the headstock are of steel, as are also many of the other gears in the machine, where strength and durability is required. All of the racks are of solid steel, and the pillow blocks for the roll necks are steel castings. The adjusting wedges under these bronze bearings are of high-carbon steel. All bearings, where necessary, are self-oiling. All oil

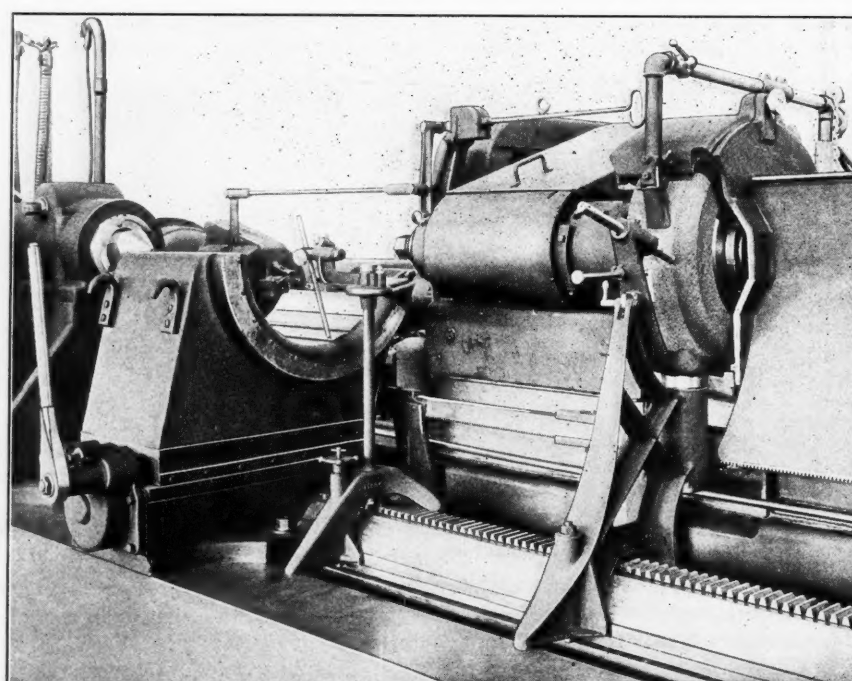


Fig. 7. Journal Rests of Norton Roll Grinding Machine showing Trammel for setting Shoes

holes are covered with a small iron cap which cannot be easily broken off, but is easily seen by the operator. All oil holes are of ample size. When desired, an attachment can be supplied for this machine, which will permit grinding rolls with either a concave or convex face. The machine as shown in the illustrations is arranged for grinding rolls either straight or with straight tapers, whether or not the rolls are carried on

centers when being ground. The machine for grinding rolls, as shown in the illustrations, weighs about 100,000 pounds.

ABBOTT RESEATER FOR THE JENKINS VALVE

The Abbott Hardware Co., 638 Columbus Ave., New York City, has recently brought out the reseating tool shown in the accompanying illustration which is designed for use on the Jenkins type of valve. The tool consists of four essential parts which are: the reseating tool, the spindle upon which the reseating tool is mounted, a sleeve surrounding the spindle, which provides for feeding the tool, and a double-cone of threaded disks which screw into the bonnet opening of the different sizes of valves for which the tool is adapted, as shown in the illustration. In reseating a valve with this tool, the right size of cutter is first mounted on the spindle, after which the threaded disk is screwed into the valve bonnet by means of the knurled wheel provided for this purpose. The cutter is then fed down to the work by operating the upper knurled wheel which rotates a threaded sleeve surrounding the spindle. The cutter is turned by rotating the handle at the end of the spindle. This tool is made for reseating valves ranging from ¼ inch up to 2 inches in size.

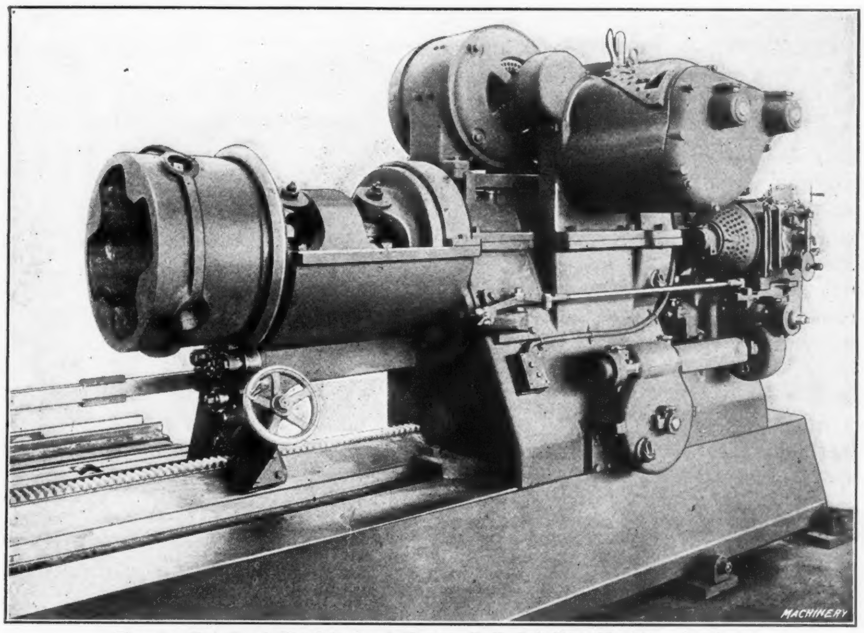
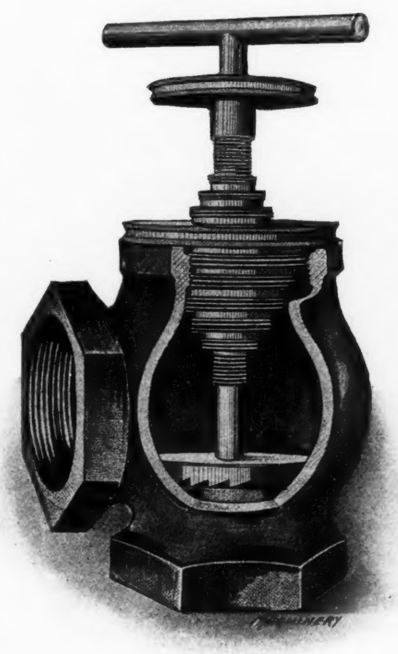


Fig. 8. Detail of Headstock of Norton Roll Grinding Machine showing Universal Joint, Locater and Driving Sleeve



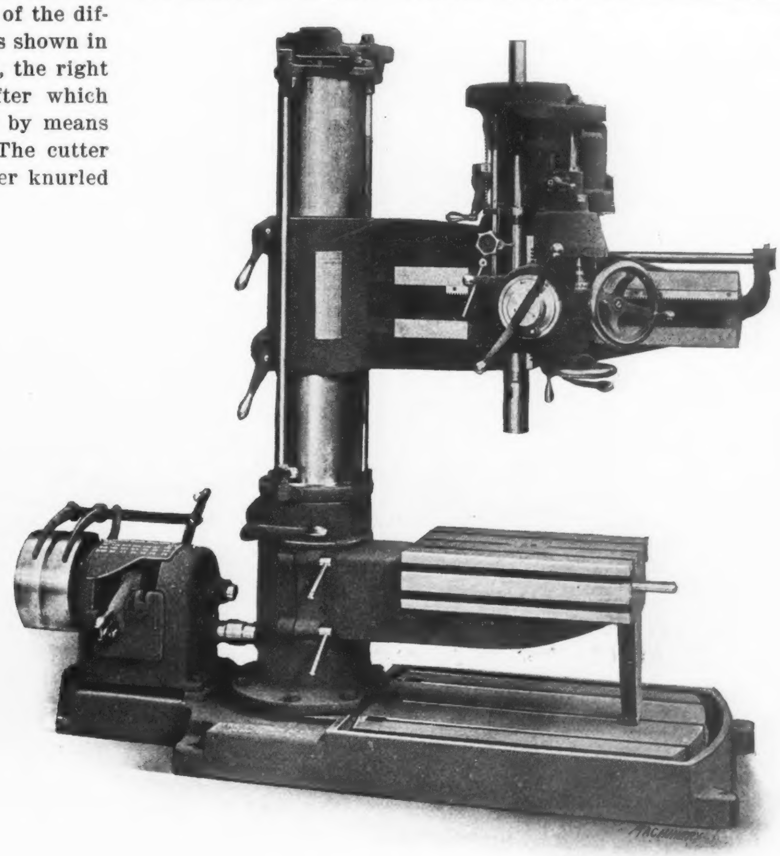
Abbott Reseater for the Jenkins Type of Valve

FOSDICK THREE-FOOT RADIAL DRILL

The three-foot radial drill illustrated herewith is a product of the Fosdick Machine Tool Co., Cincinnati, Ohio. The machine is self-contained and it requires no special foundation. As no countershaft is required, the machine may be placed directly under the lineshaft. The base is a deep triple I-beam section which insures great rigidity. It is provided with extra large T-slots and has an oil channel surrounding it which drains into a large reservoir under the column. The column is of the double tubular type. The fixed inner column is heavily ribbed and extends to the top, where a large ball thrust bearing insures easy swinging of the arm. The arm is rigidly clamped by a convenient form of malleable lever which travels with it and is made adjustable. Means have been provided for taking up wear on the clamping surface of the column.

The arm is of tubular section and is cross and vertically ribbed to give the greatest possible resistance to both torsional and bending strains. The tighteners are provided with adjusting screws to prevent sagging and to provide means for taking up wear. The elevating screw is suspended by a ball thrust bearing, and the arm lowers at twice the elevating speed by means of a handle placed in a convenient position for the operator. Safety trips are provided at both extremes of the movement. The head is moved along the arm by a rack and spiral pinion, and the thrust in either direction is taken by a ball bearing. The back gears on the head give three changes of speed through hardened steel gears and clutches, all of these changes being made while running, by means of a single lever in front of the head. All of the gears are enclosed and placed between the spindle and the friction, thus giving the friction the benefit of the back gear ratio for the heavier classes of work.

The tapping reverse frictions are mounted on a sleeve which slides on the arm shaft, the construction being such



Fosdick 3-foot Radial Drill

that grit cannot be drawn into the mechanism, which is enclosed and runs in oil. The adjustment for wear is made from the outside by means of a common screw-driver. The spindle is made of crucible steel and takes the thrust on a special form of ball bearing. The sleeve is provided with a direct reading depth gage and the adjustable automatic trip may be set to the exact depth of the hole in any position. The quick-return friction is instantly adjusted, being operated by a double lever. The feed changes are all made while the machine is running. Only one handle is required and this handle has a direct reading index. The feed-box is placed low down on the head in order to give support to both sides of the worm. The worm-wheel is enclosed and runs in an oil bath, and an "over-take" clutch permits the hand feed to be fed ahead of the power feed without disengaging the latter. The speed-box is of simple construction and positive in action; it has a direct reading index plate for the positions of the lever and all changes are made easily and noiselessly. All shock is avoided by an "over-take" arrangement which keeps the machine running at a reduced speed. A latch pin secures the tumbler and prevents chattering on heavy work.

The lubrication system consists of oil chambers and felt wipers or pipes, as the location requires, and the bearings are made of special phosphor-bronze. The machine is ordinarily equipped for belting direct to the lineshaft, but when desired it may be readily changed over for the application of individual motor drive. A constant speed or three-to-one variable speed motor of any speed may be used. In cases where motor drive is applied, rawhide gearing or a silent chain is used for connecting the motor to the machine.

CLEVELAND POWER PRESS AND PLAIN SHEAR

The open-back inclinable type power press illustrated in Fig. 1 has recently been brought out by the Cleveland Machine & Mfg. Co., Cleveland, Ohio. The inclining device consists of a rack and pinion and worm and worm-wheel, which multiplies the power applied so that one man can easily adjust the press to either the inclined or straight position. The clutch pin is mounted in a steel collar forged solid on the shaft and has a safety latch which automatically locks the pin and makes it impossible to trip the press with the treadle when the shaft is turned down for the purpose of setting dies. The slide is provided with a knock-out bar which is operated by two adjustable plates mounted at the front of the housing on each side of the slide. These plates can be tightened to suit the work in hand, and adjusted to slip under overload which would cause some part to break if the adjustment were positive. The brake band is adjusted under the tension of a spring which automatically compensates for wear and for the expansion due to heat when running the press continually. The crankshaft bearings in the frame and the flywheel are bronze bushed. The principal dimensions of the machine are as follows: Bed area, 27 inches by 18 inches; distance back from center of slide, 9½ inches; distance from bed to slide with stroke and adjustment up, 11 inches; thickness of bolster plate, 2 inches; standard stroke of slide, 2 inches; weight of flywheel, 800 pounds; total weight of machine, 4400 pounds.

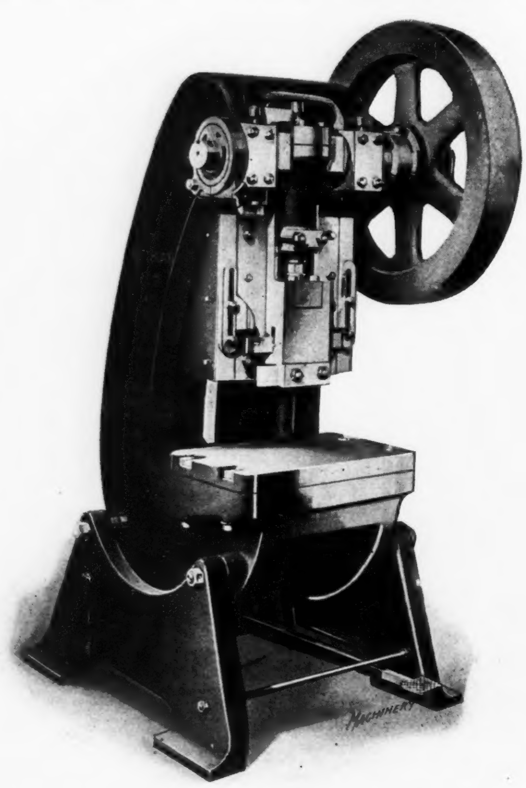


Fig. 1. Cleveland Open-back Inclinable Power Press

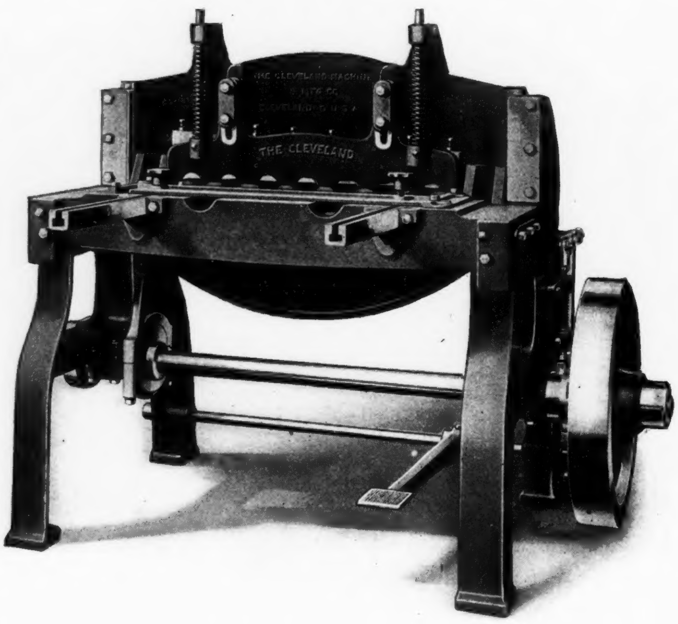
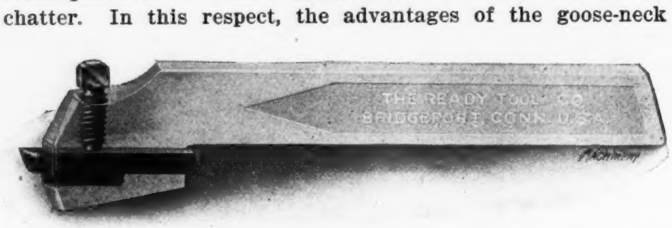


Fig. 2. Cleveland Plain Shear

Fig. 2 shows a plain power shear which has been added to the line of the Cleveland Machine & Mfg. Co. This shear has blades 31 inches in length and the capacity for cutting 18-gage steel, and has been designed to produce accurate work under hard usage. It has the same style of clutch as was described in connection with the power press. The gate has a powerful spring hold-down, and the machine is furnished with a complete set of front, rear and side gages. The total weight is 1250 pounds.

READY SHAPER AND PLANER TOOL

The illustration shows the "Red-E" style K shaper and planer tool, a recent product of the Ready Tool Co., 654 Main St., Bridgeport, Conn. An important feature of this tool-holder is the location of the cutter with reference to the holder and the tool apron. Placing the cutter back of the line of force prevents it from digging into the work and causing chatter. In this respect, the advantages of the goose-neck form of tool are obtained in connection with the increased cutting capacity of high-speed steel. The tool-holder has a piece of tool steel welded into it to form a bearing for the cutter, thus doing away with the tendency for the tool-holder to wear in the tool seat. The tool is made in three sizes adapted for using cutters of square stock 5/16 by 2½ inches, 7/16 by 3 inches and ½ by 3½ inches.



"Red-E" Style K Planer and Shaper Tool

WESTINGHOUSE INDUCTION MOTOR

The new line of type CS squirrel cage induction motors made by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., possesses several noteworthy features of design. Among these may be mentioned the extensive use of pressed steel in the construction, and rotors with cast-on short circuiting rings, and moisture and heat-resisting insulation. The use of pressed steel represents an advance in motor design. It imparts great mechanical strength and is very uniform in structure; hence a motor of given weight can be made with more active material than motors of corresponding capacity built with cast-iron frames. In these motors rolled steel forms the frames of all sizes above twenty horsepower, the end plates of the smaller sizes (which are of the so-called frameless type), and the feet and the slide rails of all sizes. As a result these motors are very compact, a feature that is of great importance in many applications. Above five horsepower the form-wound stator coils are laid out in open slots, and in case of accident, repairs can be readily made.

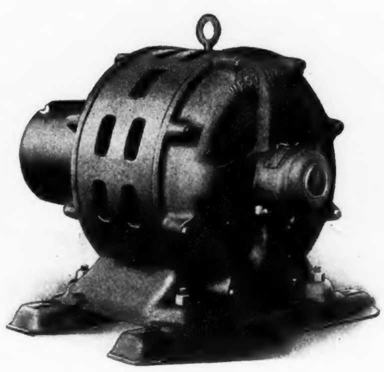


Fig. 1. Westinghouse Type CS Induction Motor

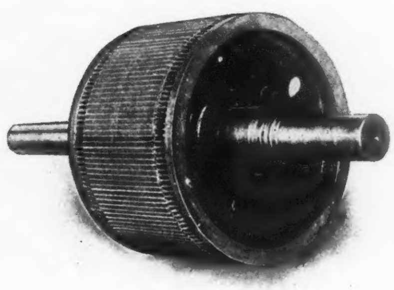


Fig. 2. Rotor of Westinghouse Type CS Motor

Fig. 3. Stator of Westinghouse Type CS Motor

The rotor construction is especially interesting. In all sizes, the rotor bars are insulated with a special cement which is moisture-resisting and will withstand a high degree of heat and mechanical stress. In motors above fifteen horsepower the bars are connected electrically and mechanically by casting the short circuiting rings around their ends. Hence there is nothing that can burn out, deteriorate under heat, or work loose under vibration. The bearings, the only wearing parts, are made of liberal size. They are protected from dust by a cap on the front end and by felt washers between metal rings on the pulley end. The efficiency and power factor are high, not only at full loads but also at fractional loads. This last feature is of special importance because industrial motors generally run at less than full load. These motors are being built in all commercial sizes from 1 to 200 horsepower.

SPRINGFIELD WET TOOL GRINDER

The illustrations show front and back views of the Brandes wet tool grinder, which was recently placed on the market by the Springfield Mfg. Co., Bridgeport, Conn. This machine combines a number of useful features in its design. The method of mounting the wheel enables a worn wheel to be removed and a new one substituted in its place without the necessity of dismantling the bearings. For this purpose, it is merely necessary to take off the hood and remove the nut from the end of the spindle. The ball bearings are of ample size to fit them for carrying a considerably greater load than they are required to support when used on this machine. They are packed with lubricant which enables them to run for extended periods of time without attention.

The necessity of a pump has been eliminated by the provision of a reservoir which is raised and lowered by means of the handwheel shown in Fig. 1. By raising this reservoir, the water is brought up to the wheel and the amount of water

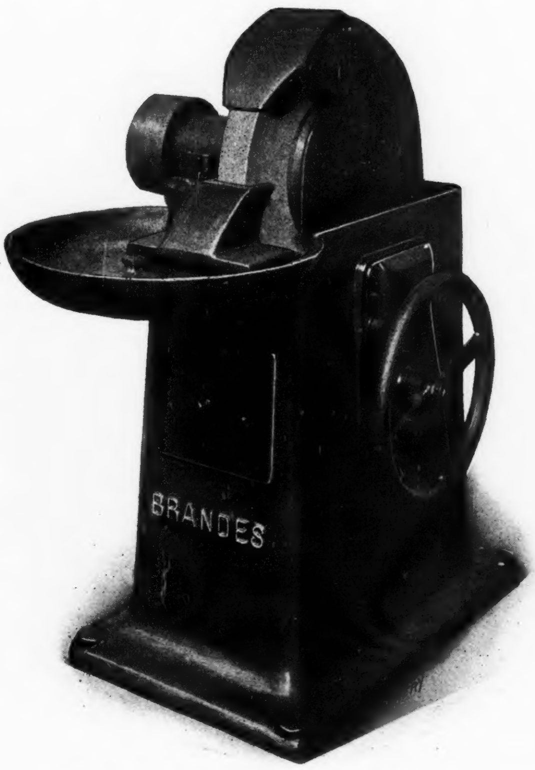


Fig. 1. Front View of Springfield Wet Tool Grinder

Fig. 2. Rear View of Springfield Wet Tool Grinder

supplied can be regulated by adjusting the height of the reservoir. The reservoir extends out from the base at the back of the machine as shown in Fig. 2, to permit filling it and also to permit of easy observation of the water level. The door shown at the front of the machine in Fig. 1 can be removed, thus providing an opening sufficiently large to enable the reservoir to be withdrawn when necessary. The water apron is exceptionally large for a machine of this size, and this apron, together with the convex surface of the tool-rest, effectually prevents the spattering of water on the floor.

Fig. 2 shows the application of individual motor drive to this machine. This construction enables a standard direct-current or alternating-current type of motor to be used, and there is ample distance between the motor and wheel spindle to give the belt a good grip on the pulleys. The machine is designed to operate at a speed of 900 revolutions per minute.

SLEEPER & HARTLEY SPRING COILER

The universal spring coiler shown in the accompanying illustrations is a recent product of Sleeper & Hartley, 98 Beacon St., Worcester, Mass. The machine is known as the No. 1 universal coiler and is automatic in operation.

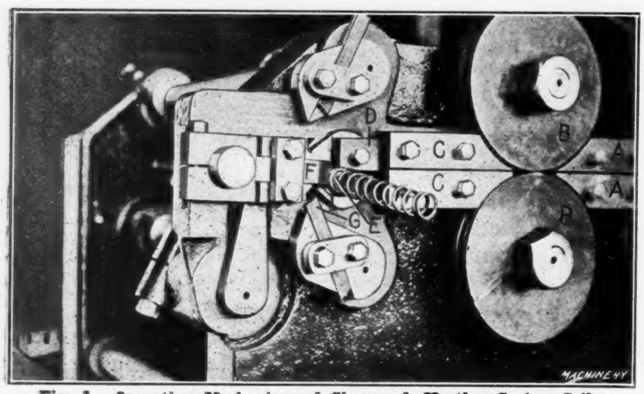


Fig. 1. Operating Mechanism of Sleeper & Hartley Spring Coiler

It takes the wire from the coil, feeds it into the machine, coils it to the required form and cuts off the finished spring. The output varies from 50 to 150 springs per minute, according to the type of spring which is being wound and the size of the wire. The machine will coil right- and left-hand

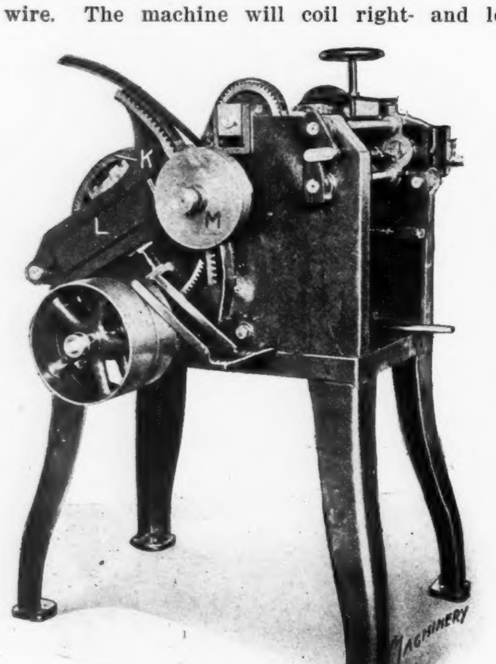


Fig. 2. Mechanism of Sleeper & Hartley Spring Coiler that controls Length of Spring

springs, two-diameter springs, conical springs with any degree of taper, and barrel springs with any desired "crowning." It will also taper one or both ends of the spring. Single rings or any desired portion of a single ring may also be formed and cut on this machine. The range of wire which can be handled is from No. 32 to No. 16 gage with a feed of from 0 to 36 inches. Springs varying from 1/8 inch to 1 inch inside diameter can be wound. The range and variety of spring forms which can be produced is indicated in Fig. 5, and it will be of interest to know that an experienced operator is able to change the machine for producing a new form of spring in from ten to twenty minutes.

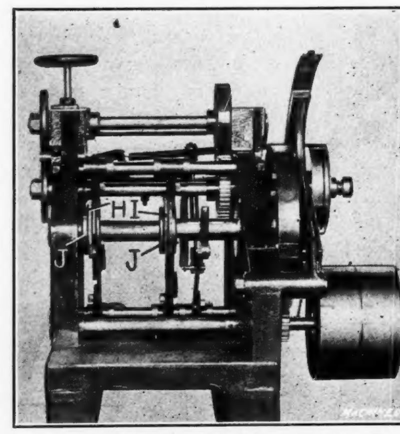


Fig. 3. End View of Machine showing Cams that control Diameter and Pitch of Spring

The operation may be briefly described as follows: The wire enters the machine through the guides *A*, passing between the adjustable feed rolls *B* by means of which it is fed forward through guides *C* under the guide *D* and over the arbor *E*. When the end of the wire strikes the coiling point *F*, it is forced into a curve of the required form for the spring which it is desired to make. The relative positions of the coiling point *F* and the arbor *E* are adjustable, and this relation determines the diameter of the

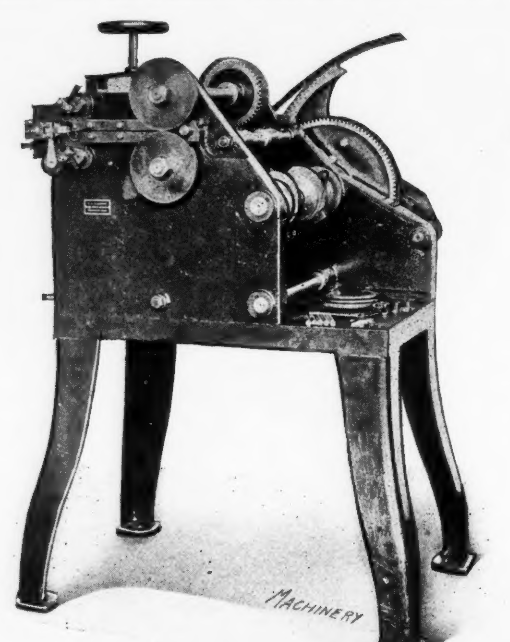


Fig. 4. Feed Mechanism of Spring Coiler shown in Detail in Fig. 1

coil that is formed. The complete spring is cut off by the knife *G*. Variations in diameter or pitch are made by means of cams *H* or *I*, Fig. 3, these cams being made in two parts which are adjustable in relation to each other and also on the

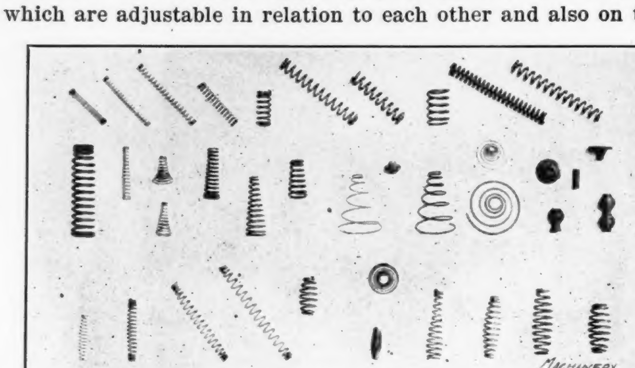


Fig. 5. Different Forms of Springs made on Sleeper & Hartley No. 1 Universal Coiler

cam hubs *J* to which they are clamped. Variations in the length of wire are effected by adjusting the position of the crank piece which slides across the gear *K*, Fig. 2. The crank piece is connected with a sliding member in segment *L* by

means of which the feed rolls are driven. An interesting mechanical feature of this machine is the noiseless ratchet M which forms the intermediate driving connection between the segment L and the feed rolls B.

GEAR GUARD FOR WALCOTT ENGINE LATHES

The Walcott & Wood Machine Tool Co., Jackson, Mich., has lately applied a new form of gear guard to all sizes of its engine lathes, which were described in the January number

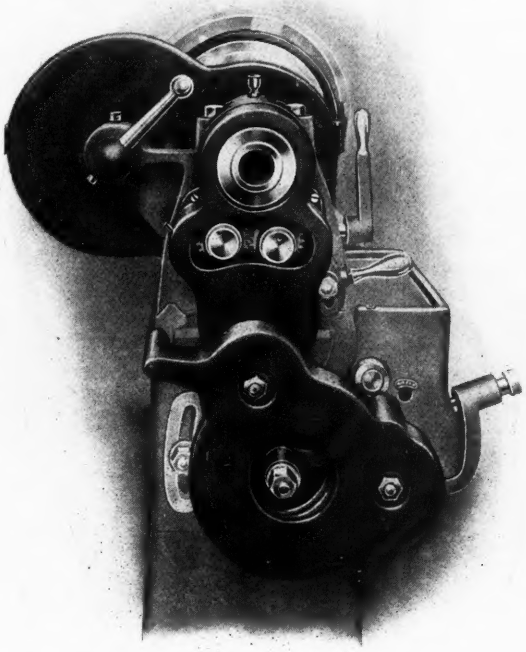


Fig. 1. Method of guarding Change Gears of Walcott Engine Lathes

of MACHINERY. The lower part of the gear guard is made integral with the headstock casting, and is machined on its top face to fit the removable or top part of the guard. This guard completely encloses the back gears and protects the

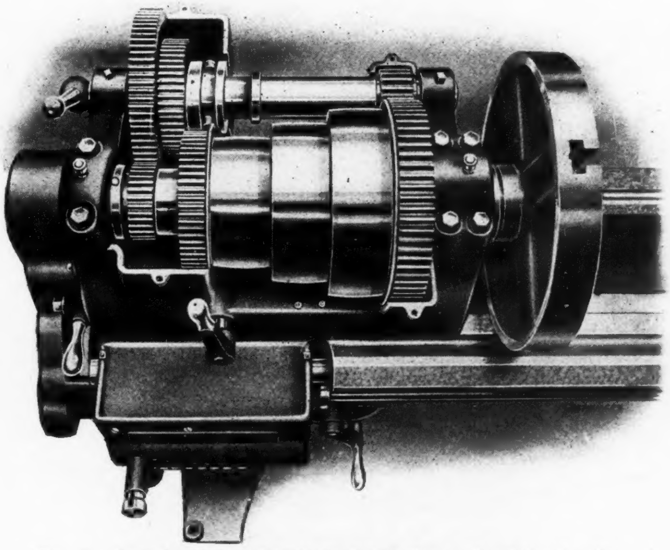


Fig. 2. Gear Guard for Walcott Engine Lathes made Integral with Headstock

operator against accidents. The change gears are also guarded, as illustrated in Fig. 1, as are also the reverse gears. These two guards can be easily and quickly removed when necessary.

Another improvement in the Walcott engine lathes is the method of shifting the sliding back gear for changing the speed of the spindle. The sliding gear is operated by the handle at the front in Fig. 2, which through a fork lever that fits in the sleeve, draws this gear over in contact with the larger gear on the cone. This is accomplished after the larger back gear has been thrown out of mesh with the smaller gear on the cone. Walcott engine lathes are now being built with the improvements here described, in 14-, 16-, 18- and 20-inch sizes.

VICTOR BOLT POINTER

The No. 2 nut facing machine built by the Victor Tool Co., Waynesboro, Pa., was illustrated and described in the June issue of MACHINERY. The illustrations presented herewith show a cutter head designed for use on this machine which adapts it for the operation of pointing or rounding bolts. When the nut facing machine is to be used for this operation, the cutter head is screwed onto the spindle of the machine and the bolt to be pointed is carried by a suitable holder on the tool carriage. The bolt is fed up to the cutter head by means of the hand lever which also feeds the facing tool up to the work when the machine is being used for its regular purpose.

The cutter head is strongly built and fitted with high-speed steel forming tools or cutters, the front and back view of

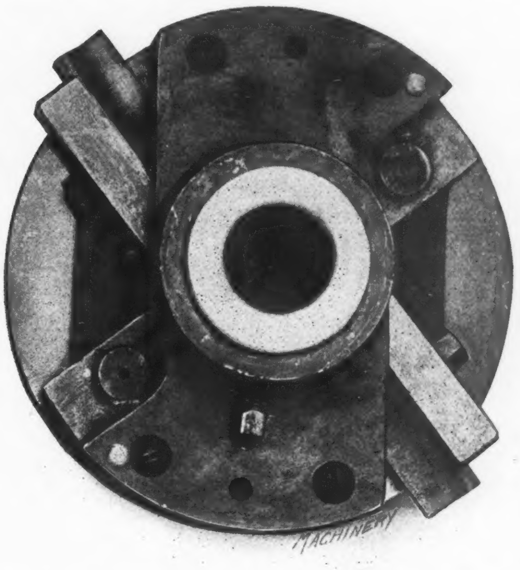


Fig. 1. Bolt Pointer for use on Victor Nut Facing Machine

the cutters being illustrated in Fig. 2. The cutters are 4½ inches in length when new and are ground to a cutting edge on one end. They can be reground until their length has been reduced to 1 inch, thus giving 3½ inches of actual wearing length to each tool. Means of adjustment are provided to enable the position of the cutters to be so regulated that one set will point or round a number of different sizes of bolts, and the design of the adjustment is such that both cutters can be regulated at the same time.

The head is fitted with hardened steel bushings for supporting the bolt while it is being pointed. Although this cut-

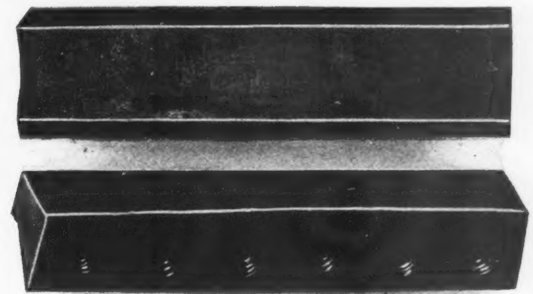


Fig. 2. Cutter used in the Victor Bolt Pointer

ter head was especially designed for use on the Victor nut facing machines, it can be attached to any bolt cutter, lathe or any other machine tool on which bolts can be pointed. The tool is of simple construction and does not require a skilled mechanic to operate it.

WESTINGHOUSE UNIVERSAL BLOW TORCH

The gasoline blow torch shown was recently placed on the market by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The design of this torch includes several improvements which adapt it for all conditions of service; hence the application of the term "universal." The burner is made particularly heavy so that it will retain its heat and keep the torch burning in cold or windy weather. The drip cup is made especially deep so that it will start the torch under adverse weather conditions. These features, however, do not detract in any way from the use of the torch for indoor work.

Another improvement is the self-cleaning burner valve. The needle at the end of the valve stem cleans the hole automatically when the valve handle is turned. Consequently, the valve seat need never be injured by picking at the opening in order to clean it. The valve seat is a separate plug which may be replaced when necessary. The handle of the valve is made of fiber and does not get hot nor require a long valve stem for cooling. It will not crack, wear loose, char nor burn. The tank is reinforced with an extra corrugated brass disk which covers the entire inner surface of the tank pot. This insures having the tank keep its proper shape under very rough handling. The pump valve works in a cylindrical guide and insures perfect seating for the valve. It can be taken apart and all parts are made replaceable. The illustrations show the quart size of torch, but this tool is also made in a pint size which is designed along the same general lines as described in the preceding paragraphs.

Fig. 1. Westinghouse Universal Blow Torch

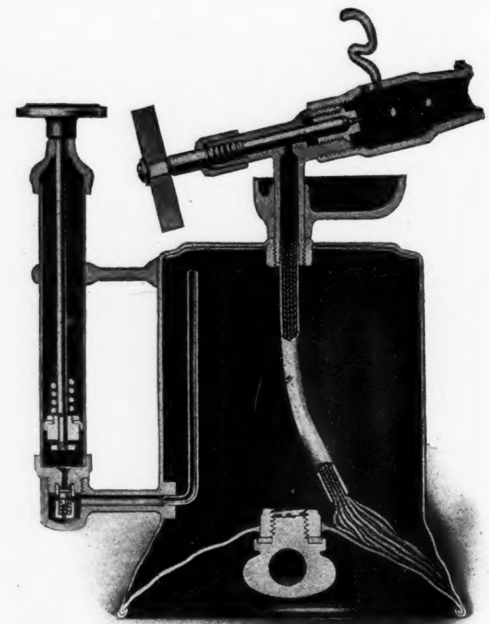


Fig. 2. Cross-sectional View of Blow Torch

SPRINGFIELD DRY GRINDERS

The illustrations show two sizes of a type of dry grinder which has been added to the line of the Springfield Mfg. Co., Bridgeport, Conn. The spindle runs in ball bearings which are carried in boxes especially designed for use on grinding machines. These boxes are made with two felt packing rings on each side of the bearing, and in addition to this protection the end shells fit closely around the shaft thus making it practically impossible for any dirt or grit to find its way into the bearings. The bearings are packed with lubricant, and the machines have been operated continuously in the factory of the manufacturers for a period of three months, at the end of which time it was said to be impossible to detect any wear or perceptible loss of lubricant.

The machines can be furnished with hoods as shown in

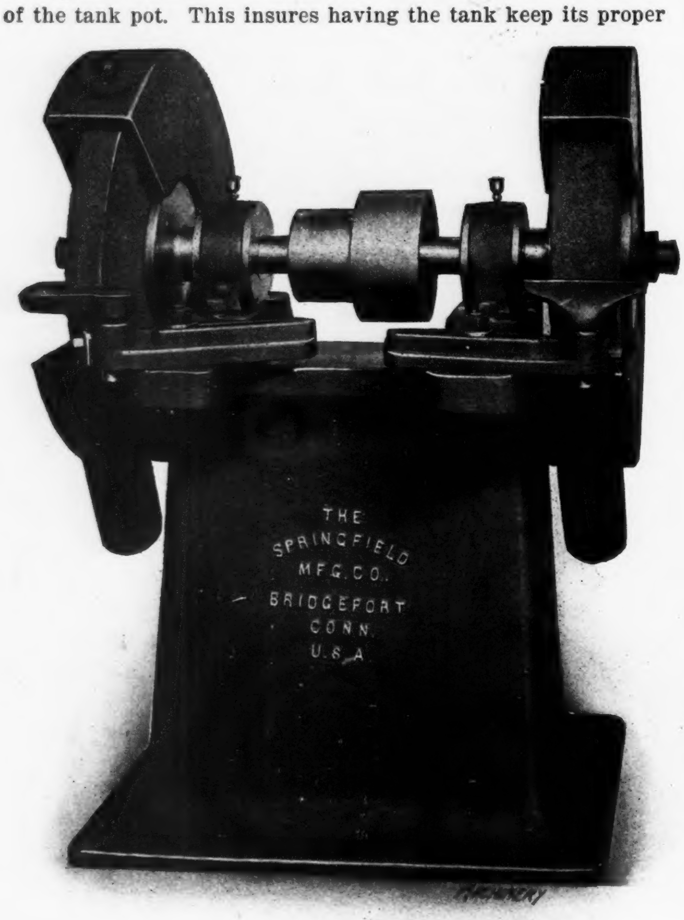


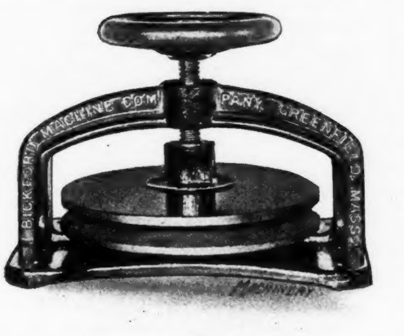
Fig. 1. No. D-B Springfield Dry Grinder

Fig. 2. No. B-B Springfield Dry Grinder

Fig. 1. Reference to this illustration will show that the hoods enclose the entire wheel with the exception of the necessary space for grinding. The ends of the hoods can be readily removed to enable wheels to be changed. These hoods are designed for use either with or without an exhaust system. The No. BB machine illustrated in Fig. 2 is designed to carry wheels up to 16 by 2 inches in size; it occupies a floor space of 20 by 27 inches and weighs 625 pounds. The No. DB machine illustrated in Fig. 1 is designed to carry wheels up to 24 by 4 inches in size; it occupies a floor space of 28 by 44½ inches and weighs 1400 pounds.

BICKFORD CEMENTING PRESS

The bench type of disk grinder made by the Bickford Machine Co., Greenfield, Mass., was illustrated and described in the May, 1913, issue of MACHINERY. The cementing press illustrated herewith has been brought out by the company for use in cementing disk wheels for the bench grinder. The design of the press will be readily understood by reference to the illustration. The disk is 10½ inches in diameter and the handwheel 7½ inches in diameter. The screw is ⅞ inch in diameter and has an Acme thread, and a ball thrust bearing is provided between the collar on the screw and a shoulder on the disk hub. The screw provides sufficient movement to enable the press to take in two disks at the same time, if necessary.



Bickford Press for cementing Disk Wheels

WENNERSTROM DIVIDING CHUCK

A dividing chuck which incorporates some interesting features in its construction is being manufactured by Wennerstrom Bros., 432 Sinclair Ave., Grand Rapids, Mich. While this chuck is particularly adapted for lathe work it can also be used to good advantage on the milling machine, where it takes the place of the usual dividing head. Its range, however, is much greater than that of the regular dividing head,

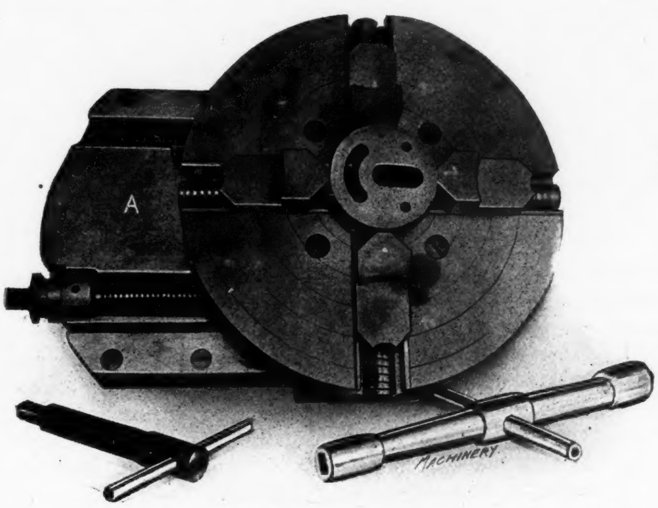


Fig. 1. The Wennerstrom Dividing Chuck for use on the Lathe or Miller

and when equipped with a base to provide for angular settings the scope of the tool is practically unlimited.

Referring to Fig. 1, the chuck consists of a base *A*, to which a second plate is fastened, the latter being provided with a threaded hole to fit the nose of the lathe spindle. The base-plate *A* is provided with V-grooves in which a carriage *B* slides, which is operated by the micrometer screw *C*. (Fig. 2.) The carriage is made to fit the rotating member *D* to which the four-jaw chuck *E* is held by four screws as shown in Fig. 1. The lower portion of the rotating member *D* is provided with worm teeth *F* which mesh with worm *G* carried on the dividing screw *H*. That portion of the rotating member *D* which fits in the carriage *B* is turned taper to an angle of 15 degrees, thus making provision for adjusting for any wear which may take place between these two members; this also makes a bearing superior to a straight surface.

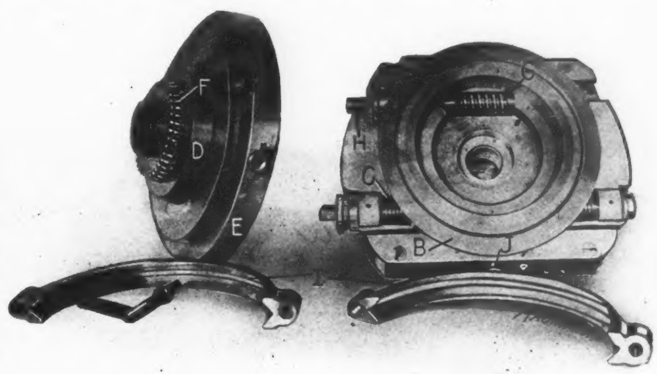


Fig. 2. Parts of the Wennerstrom Dividing Chuck

The top circular portion of the slide *B* and that portion of the rotating member *D* which comes in contact with it are provided with reverse tapered edges, which enables them to be clamped together by means of the split bronze clamping ring *I* shown in Fig. 2. When tightly clamped, this ring secures the two members together and prevents any movement while an operation is being performed on the work held in

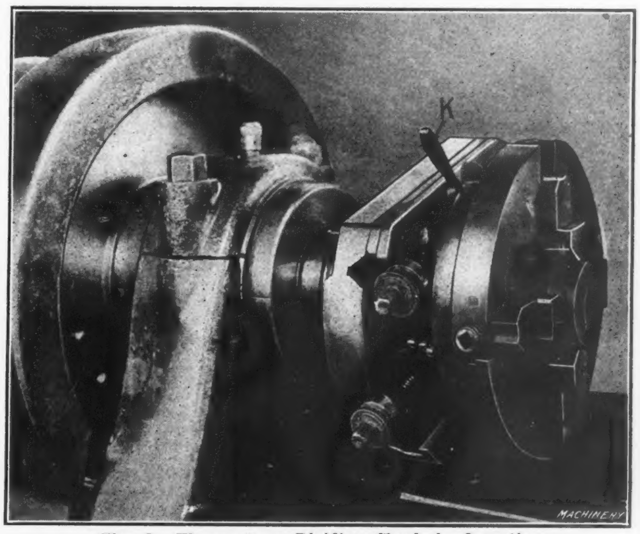


Fig. 3. Wennerstrom Dividing Chuck in Operation

the chuck. When it is required to use the chuck for producing a circular groove, the screw binding the collar *I* is loosened sufficiently to allow the rotating member *D* to be moved around.

In Fig. 3 the chuck is shown in the operating position where it is held by a hardened plunger *J* (see Fig. 2) which fits in a bushing held in the sliding member of the chuck. The hole in the bushing is longer than the plunger, allowing for wear between the two working surfaces of the sliding and rotating members. When the chuck is set off center as shown in Fig. 1, it is rigidly clamped in position by means of the lever *K* (see Fig. 3), which operates a circular segment fitting in the carriage and binding against the ways.

The chuck is of the four-jaw, independent, reversible type, the jaws of which are operated by the usual form of square threaded screws. The chuck can be taken off by removing the four clamping screws and replaced by a faceplate in order to handle work of irregular shape or of a larger size than the capacity of the chuck jaws. A ten-pitch screw with square threads operates the slide *B* and the collar on this screw has one hundred divisions enabling movements of 0.001 inch to be made. The collar on the screw operating the rotating member *D* is divided into 360 degrees. The collars are held in place by knurled nuts and when these nuts are loosened, the

collars can be set to zero. The eccentric capacity of the chuck illustrated is 4⅝ inches.

Fig. 4 illustrates examples of work handled in this chuck and gives some idea of its range. The pieces *A*, *D*, *F* and *H* show what combinations are possible by moving the slide and rotating the chuck. The pieces *A*, *D* and *H* also show what can be done with the chuck in the way of drilling equidistant holes around the circumference of a circle. The piece *E* shows what the chuck can do in the way of eccentric turning. The grooves in this piece were cut with a parting tool and the eccentricity of the different grooves was obtained by adjusting

Fig. 4. Examples of Work done in the Wennerstrom Chuck

the distance at which the chuck was set off center. The production of the hexagon hole in the piece *H* is rather an interesting operation and was accomplished with a drill and boring tool. Six holes of the required size were first drilled in the proper positions which were obtained by use of the dividing collar. The boring tool was started in one hole and the slide of the chuck moved over until one side of the hexagon was completed. The boring tool was then withdrawn and the work indexed 60 degrees, after which the boring tool was brought up to the work and another side of the hexagon completed. This procedure was followed until the six sides of the hole were machined.

In starting to produce any shape of hole or boss with this chuck, the work is first turned up with an indicator either from the outside circumference or from a prick punch mark, according to the requirements of individual cases. After this has been done, all subsequent settings are handled by the two collars on the chuck. By working out the correct relative "moves" of the micrometer and dividing collars, which can be obtained by trigonometry, it is possible to generate a perfect ellipse. Other combinations of shapes different from those shown in Fig. 4 can be obtained by using different "moves" of the two operating screws. It will be evident from a careful study of the work shown, and from the preceding description,

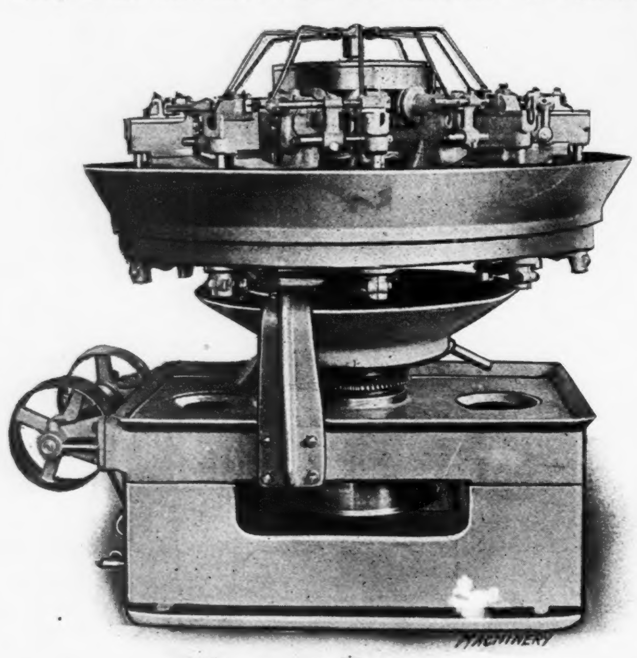


Fig. 1. Front View of Langelier Cotter Pin Hole Drilling Machine

that this chuck is admirably adapted for tool-room work—especially for the production of punches and dies. The clearance in a die can be obtained by using the compound rest and setting it over to the angle of clearance desired. This chuck will be built in three sizes, capable of handling a large range of work.

LANGELIER COTTER PIN HOLE DRILLING MACHINE

The illustrations show a machine known as the No. 1 semi-automatic ten-spindle continuous-feed drilling machine which has recently been added to the line of the Langelier Mfg. Co., Providence, R. I. This machine is particularly adapted for drilling small holes, such as cotter pin holes, in long pins, bolts, screws, nuts and work of a similar nature, and is built for various sizes of work with any number of spindles up to and including ten. In the illustrations, ten spindles are shown provided with ten work holders or vises which rotate around a stationary cam. The spindles feed outward as they rotate, each spindle operating on one piece. Nine of the spindles operate simultaneously. The tenth one is in the loading position where the operator removes the finished piece and replaces a blank which is to be drilled. The drill is withdrawn as it passes the loading position and the corresponding vise opens automatically for the operator to remove the work and replace it with a blank.

The operator can either sit or stand, as desired, while inserting fresh blanks in the vises. The vises are closed either automatically or by means of a foot treadle. All that the operator has to do is to remove the finished pieces and insert blanks in the vises which can be made to hold pieces of various sizes and shapes. Either vertical or horizontal vises

Fig 2. Rear View of Cotter Pin Hole Drilling Machine

may be used, the style being determined by the class of work upon which the machine is to operate. When long pieces are to be drilled, the vises are made to hold the work in a vertical position, the work extending up any reasonable length that can be operated upon. On some classes of work an automatic ejecting device can be used to advantage so that when the jaws open automatically the work will be forced out. With a machine equipped in this way, all that the operator has to do is to place fresh blanks in the vises.

The spindles are hardened and ground and run in phosphor-bronze bearings. The maximum feed travel is 1½ inch, and the chucks will take drills up to ¼ inch in diameter. The feed cam that operates the spindles is easily removed so that cams to give different ranges may readily be substituted. When deep holes are to be drilled, the cams are made to withdraw the drills frequently, thus breaking and clearing the chips from the holes. The feed of the drills can be changed to suit the depth of holes and the sizes of drills.

Provision is made for ample lubrication of the drills, the lubricant being forced between the vise jaws and the work, thus keeping the work flooded at the point of drilling so that

the highest possible feed and cutting speed may be employed. A circular pan surrounds the ten drilling heads, this pan having ample capacity for holding the drilled work and chips. The oil is strained and drained into the base, where it is pumped back to the work by a circulating pump. An idea of the productive capacity of the machine will be obtained from the following example: Automobile chain pins ½ inch in diameter are drilled with 0.121-inch drills running at 2200 revolutions per minute, the production being 20 pins per minute. The capacity of the machine for round pieces with two sets of vise jaws is from ¼ to 1 inch, the first set taking from ¼ to ⅝ inch and the second set from ⅝ inch to 1 inch. The jaws carry a drill guide bushing which centers the drill accurately. These jaws can be very quickly changed when it is required to operate the machine on some other class of work.

BLISS DOUBLE-CRANK TOGGLE DRAWING PRESS

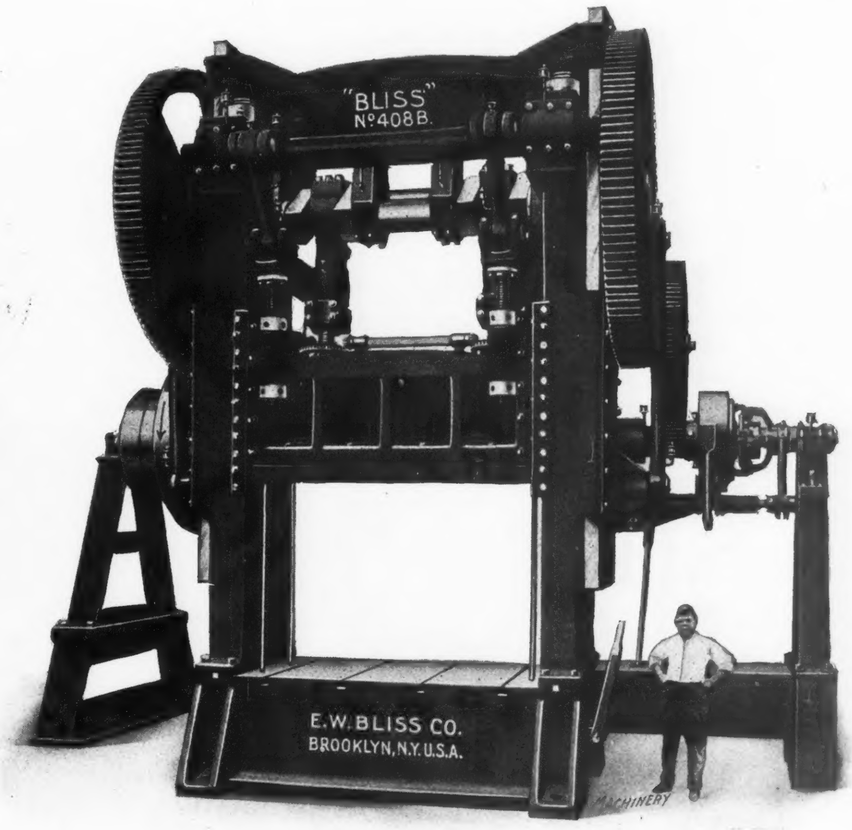
The double-crank toggle drawing press illustrated herewith was designed by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for use in drawing and forming operations on heavy gage sheet metal. The machine is particularly adapted for drawing and forming articles of large area and considerable depth, such as automobile radiators, fenders, stove tops and similar classes of work. For operations of this nature it has several features which make it more efficient than a standard double-crank press used in connection with spring pressure attachments.

The construction is what is known as the tie-rod type, in which the bed, uprights and crown piece are tied together by four vertical steel tie-rods which are shrunk in place and take the entire working strain, thus relieving all cast-iron parts from tensional stresses. The design of the machine is such that power is transferred from the main driving gears to the outside slide or blank-holder through a series of toggles, and a dwell of 110 degrees is provided. The number of toggles and connections used has been reduced as far as possible. In order to maintain this simple and efficient construction in a wide press of the type illustrated and at the same time avoid any torsional strain, it will be noted that power is transferred to the outside slide or blank-holder from both ends of the press. This construction is also followed in connection with the crankshaft which operates the inner slide, a driving gear being mounted on each end of the shaft. The small number of connections or links used in transferring power to the outside slide or blank-holder insures a minimum power consumption, and, in addition, makes a simple, compact and strong construction in which wear is reduced to a minimum. In this connection it may be mentioned that the connecting pins are hardened and ground to reduce wear.

Control of the machine is effected by a powerful hand-actuated friction clutch of the double-grip type, by which means the operator has the moving parts under control at all times. Both the flywheel and tight pulley are arranged with safety couplings as a precaution against possible accidents or damage to the machine resulting from dies being incorrectly set. The machine is double geared, the ratio of the gearing being 42 to 1. The entire train of gears is machined from steel castings, the loose pulley and all back shaft bearings are bronze bushed, and the bushings have babbitt with graphite cast in them to aid lubrication.

The inside slide is counterweighted by weights placed in the driving gears and the outside slide or blank-holder is counterweighted by the outside crossheads which, in addition form the direct link between the rocker shafts and driving gears. Adjustment of the outside slide or blank-holder is effected by means of four screws which are plainly shown in the illustration. Adjustment of the inner slide is made by adjusting screws which operate together, keeping the faces of the slide and bed in correct alignment. In the larger sized machines these adjustments are operated by an independent motor mounted on the slide.

The press illustrated is one of a series which the Bliss Co. has recently built, and while this particular machine is not the largest of the series it will be evident from the illustration that it is of very large proportions. The total height is 19 feet; the machine occupies a floor space of 235 by 104 inches and has a total weight of 120,000 pounds.



Bliss Double-crank Toggle Drawing Press weighing 120,000 Pounds

HOUGHTON & RICHARDS CUTTING-OFF MACHINE

Houghton & Richards, 1394 West Third St., Cleveland, Ohio, are now building the drop-arm type of cutting-off machine illustrated in Figs. 1 and 2. This machine has been designed to meet the demand for a machine that will cut off long bar stock squarely and that will also cut a great variety of irregular shapes in metal. The range of the machine may be gathered from the fact that any class of work that can be done on an ordinary band saw designed for cutting wood can be handled on this metal cutting band saw. The feed mechanism is of the gravity type and is operated by the weight of the drop-arm, but the action of this weight is governed by a drum friction equipped with a bank brake. The arm is attached to the winding drum by a ¼-inch steel wire cable and the drum is geared to the large handwheel at the front of the machine by means of small bevel gears. The arm is raised or lowered by turning this handwheel.

There is a cam on the upper driving shaft which can be adjusted for any depth of cut by unscrewing a bolt with a large knob which is located to the left of the pulleys. As the arm descends, this cam engages a steel roller on the shifting lever, and by the aid of a small trigger shifts the belt to the loose pulley. Attached to the shifter rod is a small arm which operates the vertical shaft passing through the curved pedestal. This arm is connected with the horizontal shaft below the table of the machine, which governs a lifting device. This lifting device causes a pawl to lower and engage

a ratchet wheel cast on the hub of the large handwheel, which raises and lowers the arm. When the lifting device is down, the pawl is engaged with the ratchet and the handwheel must be turned by hand in order to release the

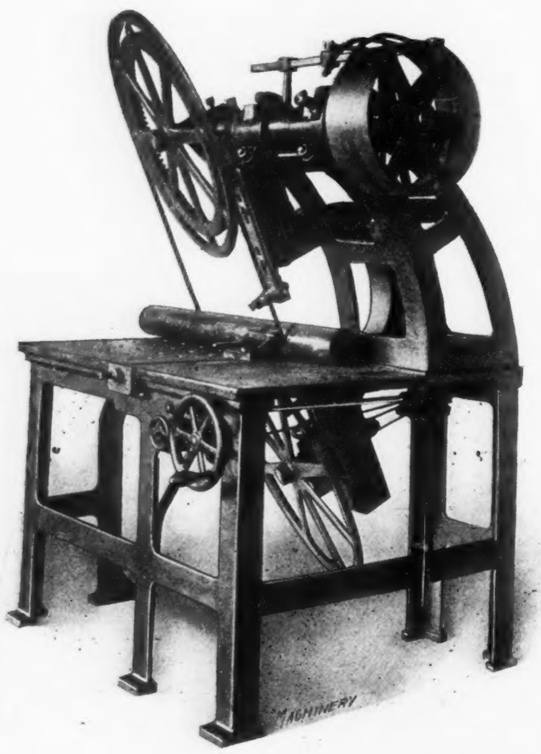


Fig. 1. Houghton & Richards Cutting-off Machine in Use on Bar Stock

ratchet. If this is not done, the belt shifting rod will not move to start the machine. This device locks the arm as soon as the saw has cut through the piece upon which it is working, and makes it impossible to start the machine until the lock

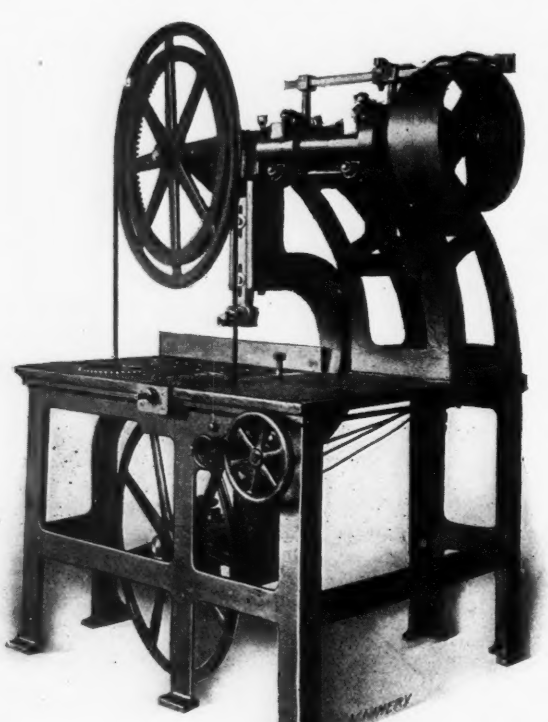


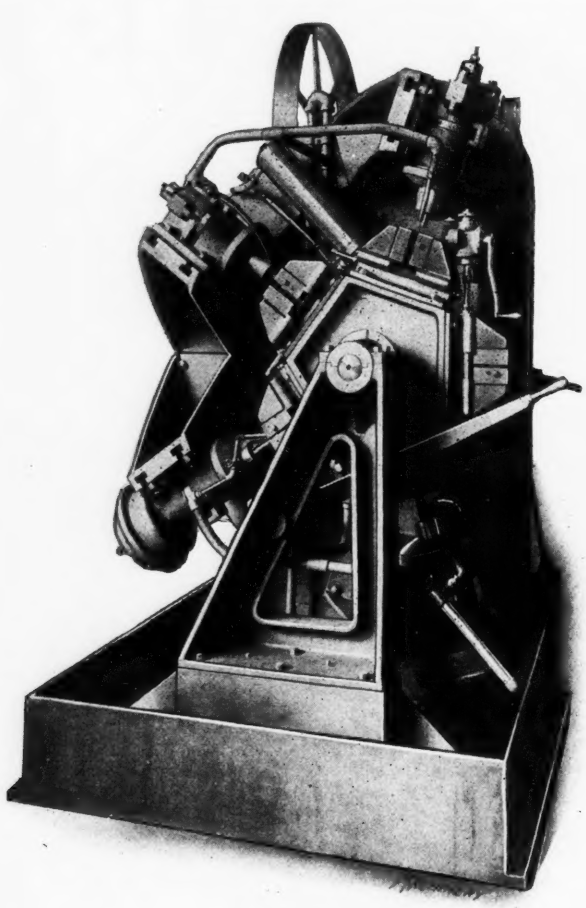
Fig. 2. Houghton & Richards Cutting-off Machine engaged on Die Work

of the arm has been released. This does away with the danger of prematurely starting the machine.

The size of band saw used is 0.031 inch in thickness by 5/8 inch wide. The thinness of this blade is the means of effecting a material saving in cutting expensive material such as high-speed steel, which is said to be great enough to enable the machine to pay for itself in a very short time. Experience has shown that the average life of one of these saws is terminated after it has cut about 1500 square inches of tool steel, the speed at which the band saw is operated averaging from 120 to 135 feet per minute. The actual time required to cut off a six-inch round bar of tungsten steel is from 16 to 20 minutes, depending upon whether a 14-tooth or a 10-tooth saw is used. These machines are built for either belt drive or direct motor drive. In the latter case, the motor is mounted on the curved pedestal and geared direct to the machine, the starting box being fastened to the sides of the pedestal. This makes a very compact arrangement, in which all of the moving parts are above the table. Three sizes of machines are built for cutting up to 6-, 8- and 12-inch square or round stock.

POTTSTOWN REAMING, COUNTERBORING AND TAPPING MACHINE

The machine shown in the accompanying illustration was designed by the Pottstown Machine Co., Pottstown, Pa., for use in reaming, counterboring and tapping superheater return bends or work of a similar nature. The machine has four spindles, two of which are used for reaming and counterboring and two for tapping operations. The reaming spindles



Pottstown Machine for reaming, counterboring and tapping Superheater Return Bends

are located below the center of the turret and feed upward, thus permitting the chips to drop out by gravity. The taps are fed in by lead-screws having the same pitch as that of the thread which is desired. The machine is equipped with a revolving turret which has five chucks. The work held in four of these chucks is being operated on by the spindles of the machine while the operator is removing the finished piece from the fifth chuck and replacing it with a fresh blank. The turret is revolved and indexed by a pneumatic attachment, and a fixed wrench is provided for closing the chuck jaws.

The machine is equipped with the standard form of reversing mechanism applied to machines of this company's manu-

facture. This mechanism does not vary in time of reversing, and thus insures having the work tapped uniformly to gage. A rotary geared pump is provided for furnishing lubricant to the taps and reamers. The four heads are adjustable on the housing brackets to adapt the machine for different sizes of work. The machine proper is mounted on a base which has a deep pan cast integral with it. This pan serves as a reservoir for the lubricant and also catches chips and drippings. All the gears used in the machine are made of 40 carbon cast steel with cut teeth, and all the gearing is entirely enclosed. The total weight of the machine is 15,000 pounds.

EVELAND POWER-DRIVEN ELECTRIC RIVETER

The power-driven electric riveter illustrated in the halftone Fig. 1 is a product of the Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa. As in the case of all the electric riveting machines manufactured by this company, the rivet is placed in position and heated by electricity, after which the head is formed by a rivet set carried by the ram of the machine. An interesting feature of the machine shown in the illustration is the application of power for driving the ram. The electric motor used for this

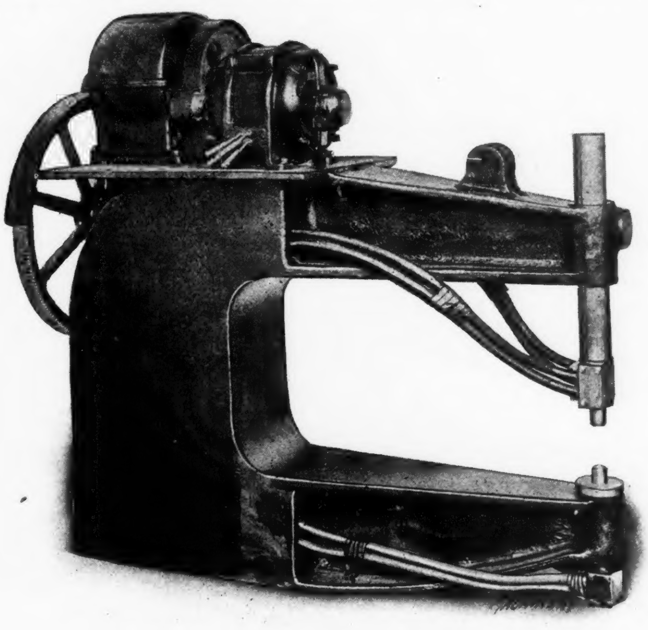


Fig. 1. Eveland Power-driven Electric Riveting Machine

purpose is connected to the same alternating-current circuit that is used for heating the rivet. The gears are of ample strength to transmit the necessary pressure, which may vary from a few hundred pounds up to fifty tons according to the requirements of the work.

The machine is automatic in its operation, being provided with a motor-driven variable speed attachment by means of which the operator may regulate the pressure as well as the rapidity with which the rivet is heated by merely pressing push-buttons. One operator, with a helper to handle the work, can rivet pieces together on this machine at any angle and on work of any shape, the rivets being placed in position and heated automatically, after which—by simply pressing a push-button—the ram will descend and head the rivet. By pressing another push-button, the ram is returned to its original position. The machine will force a rivet into place, and, if necessary, straighten the bar in which it is carried and then return to its normal position in a period of time varying from 8 to 15 seconds according to the shape of the work and diameter and length of the rivet.

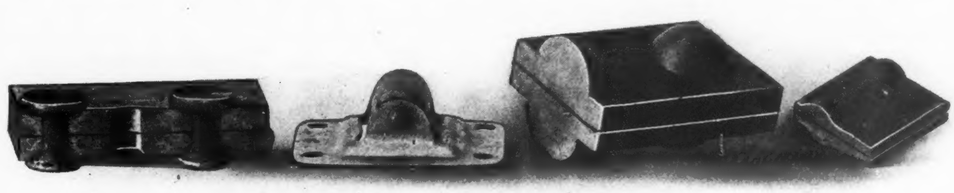


Fig. 2. Examples of Work done on the Eveland Riveter

These electric riveters will handle any size, shape or length of rivets made of iron, steel, brass, copper or other metal. The machines are capable of developing any temperature up to and even exceeding 2000 degrees F., and a regulating device can be provided which enables the rivets to be heated to any required maximum temperature. Where the holes in which the rivets are placed are not reamed, the metal in the rivet may be heated to a sufficiently high temperature so that the pressure will cause the metal to flow enough to completely fill the hole, thus making a very solid joint. The machine shown in Fig. 1 will take a flat plate or sheet up to 36 inches in width and bars or plates up to 20 inches in height.

WESTINGHOUSE SINGLE-PHASE MOTOR

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has placed on the market a new line of single-phase motors,

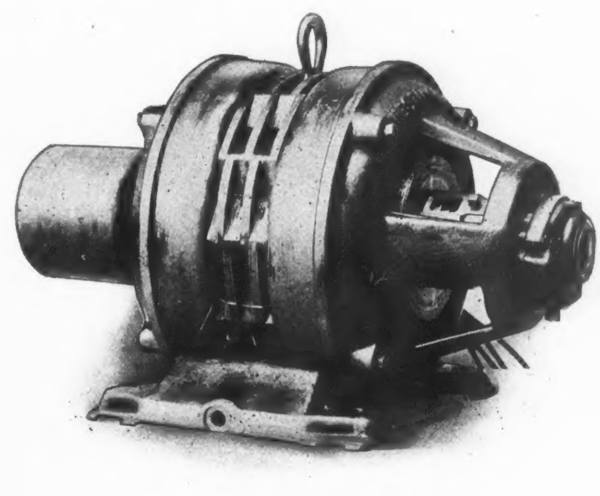


Fig. 1. Westinghouse Type AR Motor

made in capacities of from 2 to 10 horsepower and suitable for the majority of constant-speed applications within their capacities. These motors are of the repulsion-starting type, and when up to speed run as induction motors. For most applications they can be connected directly to the line, but where a very low starting current is desired a starting rheostat can be used.

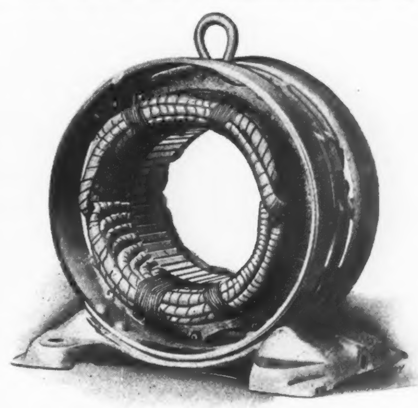


Fig. 2. Stator of Westinghouse Type AR Motor

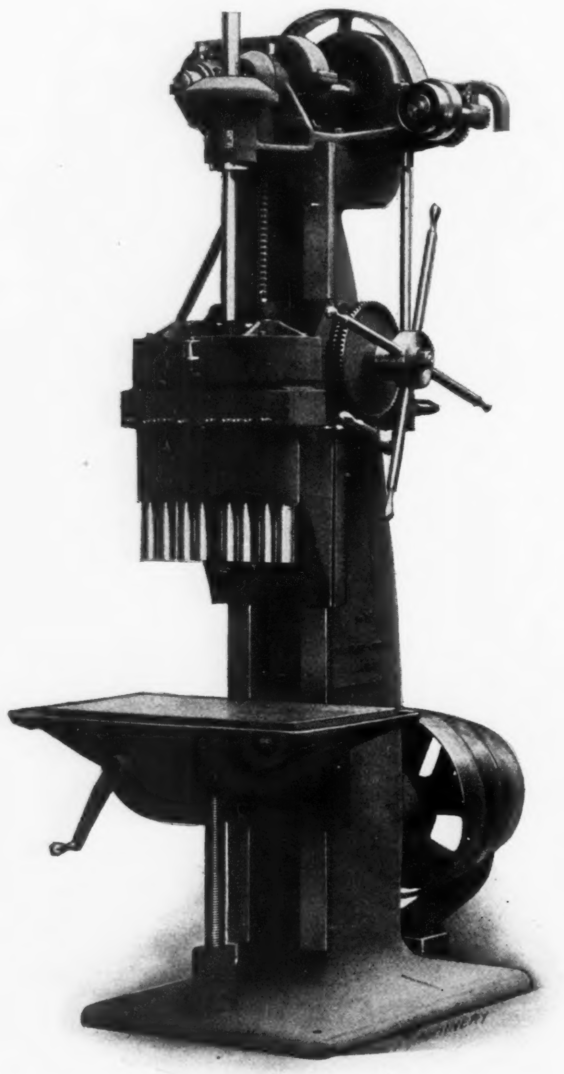
The frame is so designed that it combines great strength and radiating capacity with the minimum weight and over-all dimensions. The laminations are riveted together under pressure and pressed steel end plates are riveted to the unit thus formed. The foot, or base, is of pressed steel plate securely riveted to the end plates. This use of pressed steel marks an important step forward in the design of large single-phase motors.

The bearings are large and dust-proof. The rotor coils are form-wound and arranged to permit excellent ventilation. The commutator is of the radial type with undercut mica segments. The shaft can be pressed out of the rotor without

disturbing the windings or the commutator. Each motor can be arranged for operation on either 110 or 220 volt circuits.

FOOTE-BURT MULTIPLE SPINDLE DRILL

The eight-spindle, fixed-center drill illustrated herewith was brought out by the Foote-Burt Co., of Cleveland, Ohio, and is one type of their No. 15½ multiple spindle drills. This machine is built with any desired number of spindles, which can be arranged to be either universally adjustable, adjustable in a straight line, or on fixed centers as shown in the illustration. The machine was designed for handling automobile work and is extensively used on the valve hole work on automobile cylinder castings. It is also used for drilling the sides of a crank-case or for any other multiple work which is required. It has found extensive application on valve



Foote-Burt No. 15½ Multiple Spindle Drill

hole work for boring large valve port holes and also for machining valve seats and drilling and reaming the valve stem guide hole. With this type of machine having the proper number of spindles—either adjustable in a straight line or with fixed centers—a manufacturer is able to machine the number of valve holes required on the cylinder as quickly as one hole could be machined with a single spindle machine.

The spindles have large bearings and are bronze bushed. The driving spindle spur gears are made of 3½ per cent nickel-steel and the head slide on the column is of ample length to insure the necessary rigidity. The driving bevel gears are made of high carbon drop-forgings having planed teeth. The machine is arranged with friction throw-out back gears, a Johnson friction clutch being used. This arrangement is for taking care of the large range of sizes between the large valve hole and the valve stem guide hole upon which the machine is operated and also adds to the power of the machine. The drive is from a three-step cone pulley having steps 15, 17 and 19 inches in diameter by 4½ inches face. Six changes of power feed are provided by means of a two-step cone pulley and change feed gears. The column of the machine is of box section and the table has a large working surface with an oil groove entirely surrounding it. The table is raised and lowered by means of a screw and spiral gearing.

NEW MACHINERY AND TOOLS NOTES

Universal Testing Machine: Shore Instrument Co., 555 West 22nd St., New York City. A machine adapted for conducting tension and bending tests on steel and other metals.

Stillson Wrenches: Oswego Tool Co., Oswego, N. Y. Stillson wrenches made in a variety of sizes and styles for different classes of service. These tools are made of drop-forged tool steel.

Power Hacksaw: W. D. Pratt, Canton, Ohio. A hacksaw machine provided with a quick-return mechanism and adjusment for changing the length of the stroke and position of the swivel vise so that either end of the blade can be used.

Boring Mill with Rapid Power Traverse: Betts Machine Co., Wilmington, Del. A boring mill equipped with separate motor drive for providing rapid power traverse. Another feature of this machine is the use of an all-geared feed to the heads.

Bolt Turning Machine: Pawtucket Mfg. Co., Pawtucket, R. I. A machine designed for turning straight or taper bolts within a limit of 0.001 inch. The machine has a capacity for turning bolts up to and including 1½ inch in diameter by 20 inches in length.

Electric Arc Welding Machine: C. & C. Electric & Mfg. Co., Garwood, N. J. An electric welding machine adapted for such work as repairing blowholes in castings, etc., and for repairing breaks in street car tracks, locomotive frames and similar classes of work.

Duplex Milling Machine: Hoefer Mfg. Co., Freeport, Ill. A duplex milling machine adapted for milling both ends of automobile front axles simultaneously, thus avoiding the loss of time involved in changing the work, end for end, between successive milling operations.

Air-driven Breast Drill: Smith Drill & Machinery Co., Chattanooga, Tenn. This tool is driven by a small air turbine and will take drills up to ½ inch in size. The tool operates satisfactorily on 35 pounds per square inch air pressure and consumes 15 cubic feet of air per minute.

Herringbone Gear Hobber: Fawcus Machine Co., Pittsburg, Pa. A machine designed for hobbing herringbone gears of small and medium sizes. The maximum capacity of the machine is for gears 48 inches in diameter by 20 inches face, and the minimum diameter that can be cut is 1½ inch.

High-speed Riveter: H. P. Townsend Mfg. Co., Hartford, Conn. A riveter especially designed for setting the sparking points in automobile spark plugs. The head of the machine contains the regular mechanism of this company's riveters which strikes approximately 15,000 blows per minute.

Motor-driven Grinders: Forbes & Myers, Worcester, Mass. A line of motor-driven grinders adapted for medium and heavy work. The armature spindle of the motor which drives these machines is extended to provide a mounting for the wheels, and the electrical parts are totally enclosed, making them dust-proof.

Oil Grooving Machine: Fischer Machine Co., Philadelphia, Pa. A machine which operates automatically after the bearing has been set in place. The tool-slide is linked to an adjustable connecting-rod which gives a reciprocating motion, and the necessary change gears are provided for cutting different styles of oil grooves.

Electric Hardening Furnace: General Electric Co., Schenectady, N. Y. An electric furnace consisting of a crucible in which the bath is heated by two electrodes. The crucible is surrounded by brickwork to prevent the possibility of the bath being spilled onto the floor, and the entire furnace is enclosed in a sheet-iron case.

Multiple Disk Brake: Cutler Hammer Clutch Co., Milwaukee, Wis. A multiple disk brake intended for use on crane-hoists, rolling mills, etc. The fundamental parts of the brake mechanism consist of a magnetic case, a compression spring, a hub and a series of stationary and rotating disks, the entire mechanism being enclosed in a substantial case.

Screw Cutting Precision Bench Lathe: Cincinnati Precision Lathe Co., Cincinnati, Ohio. A screw cutting precision bench lathe in which no universal joints are used in the screw cutting attachment, the drive being entirely through gears. The machine has a capacity for cutting ten to eighty threads per inch and the spindle takes Rivett No. 4 collets.

Casehardening Boxes: Hess Steel Castings Co., Philadelphia, Pa. This company has recently standardized its line of casehardening boxes to meet the requirements of common practice. The sides of these boxes are made thicker along their upper edge, as experience has shown this to be the point of maximum wear. Special means of handling have also been provided.

Spring Machines: Sleeper & Hartley., Worcester, Mass. A plain spring coiling machine which takes wire from the coil and produces either open or closed extension springs in lengths up to 150 feet or more. The second machine is a helical cutting and hooking machine which produces the helical springs that are used in the manufacture of spring beds.

Combination Punch and Shear: Wiener Machinery Co., 50 Church St., New York City. A combination punch and shear designed for handling practically any class of cutting, shearing, coping, mitering and notching. The frame of the machine is made of steel. The machine is built in three sizes and can be equipped for belt drive or for direct-connected motor drive.

Horizontal Boring Machine: Termaat & Monohan Co., Oshkosh, Wis. A machine designed for boring gas engine cylinders. The work is clamped to the carriage and the spindle is driven through the bore. A facing head is attached at the head end of the spindle, and for facing the other end a stand is mounted on the carriage and the cutter bar extended to slip through the facing head to drive it.

Universal Tool and Cutter Grinder: Woods Engineering Co., Alliance, Ohio. A machine designed to meet the requirements of tool-room grinding. The elevating and cross-travel screws are provided with micrometer dials. The longitudinal table is of deep box section and adjustable stops are clamped to the face of this table in a T-slot to afford a positive stop for grinding up to shoulders. The top table swivels on a central stud and has a bearing for its full length without overhang.

Radial Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A 6-foot, heavy-duty, radial drill in which the trunnions for the arm are provided with roller bearings and the weight of the arm is supported by a ball thrust bearing. The head is carried on a pair of rollers, backed up by heavy springs, and the gearing in the head is entirely enclosed in an oil-tight casing. The drive is obtained from a variable-speed motor through two nests of back gears, one on each side of the spindle.

Cutter Clearance Gage: Brown & Sharpe Mfg. Co., Providence, R. I. This gage consists of a steel bar 6½ inches long which carries a stud at one end on which the cutters are mounted. Five hardened steel bushings are provided to fit over this stud and carry cutters having holes 1, 1¼, 1½, 1¾ and 2 inches in diameter. The gage is mounted on a slide which is easily moved along the bar. The gage is attached to the slide by means of a pin which allows it to be revolved, one end being used for cutters under 3 inches in diameter and the other end for cutters of 3 inches and over. To test for the correct clearance, the cutter is placed on the stud and the gage pushed forward. The cutter is then revolved sufficiently to bring the face of a tooth into contact with a stop of the gage which gives the correct position for the cutter. The angle of clearance on the tooth should then correspond to the angle on the gage.

* * *

FIELD DAY OF GREENFIELD TAP AND DIE MAKERS

The employes of Wells Bros. Co., Wiley & Russell Mfg. Co., and A. J. Smart Mfg. Co., Greenfield, Mass., had their second annual field day at Island Park, Brattleboro, Vt., July 26. The employes formed a line of march in Greenfield, headed by the grand marshal, Frederick H. Payne and the Greenfield military band. The parade marched to the Boston & Maine R. R. station, and there took a special train for Brattleboro. The events included 100-yard dash; shot put; jumping; sack and potato races; hop, step and jump; tug-of-war, etc. Gold, silver and bronze medals were awarded to the successful contestants; and the banner of the organization was awarded to the employes of the Wiley & Russell shop, for scoring the greatest number of points in the events. In the afternoon, a baseball game between the "Lightnings" and "Little Giants" afforded the "fans" a chance to root for their respective sides. A grand minstrel show was also one of the events of the day. A tastefully arranged program of events contained a list of the old guard, comprising members identified with the concerns dating back to 1872. "The purpose of the old guard is the perpetuation, in a brotherhood, of the personal relations brought into existence through association together as employes, and to provide the employers with a means through which their appreciation of faithful service may be fittingly acknowledged." Membership in the guard is based on ten years' continuous service, regardless of position, and there are seventy-three members.

PERSONALS

C. R. Rothwell, general manager of the Lea-Courtenay Co., Inc., 90 West St., New York City, sailed June 28 for a two-months' trip to England and the Continent. Mr. Rothwell will combine business with pleasure.

W. H. Williams, formerly in the Pittsburg office of the Electric Controller & Mfg. Co., Cleveland, Ohio, has been transferred to the Chicago office of the same company to assume the duties of district manager in the Chicago territory.

Alexander E. Pribil, who has been in charge of the bolt and automobile grease cup departments of the Penberthy Injector Co., Detroit, Mich., is now in the employ of the Winkley Co., of Detroit, in charge of the same departments, which have been sold by the Penberthy Injector Co. to the Winkley Co.

Ysidoro Arnaiz, a Cuban nearly eighty-three years old, has just begun his seventieth year of continuous service with R. Hoe & Co., New York City, builders of printing presses. Mr. Arnaiz was apprenticed to Robert Hoe at thirteen, when only about one hundred people were employed. Now the concern employs nearly three thousand.

L. B. Campbell has resigned his position with Mr. H. L. Thompson, consulting engineer, of Waterbury, Conn., to take a position with the American Chain Co. Mr. Campbell, who is the son of Mr. A. C. Campbell, inventor of a new type of cotter pin, is a technical graduate and has had practical experience with a number of manufacturing concerns in New England.

* * *

OBITUARIES

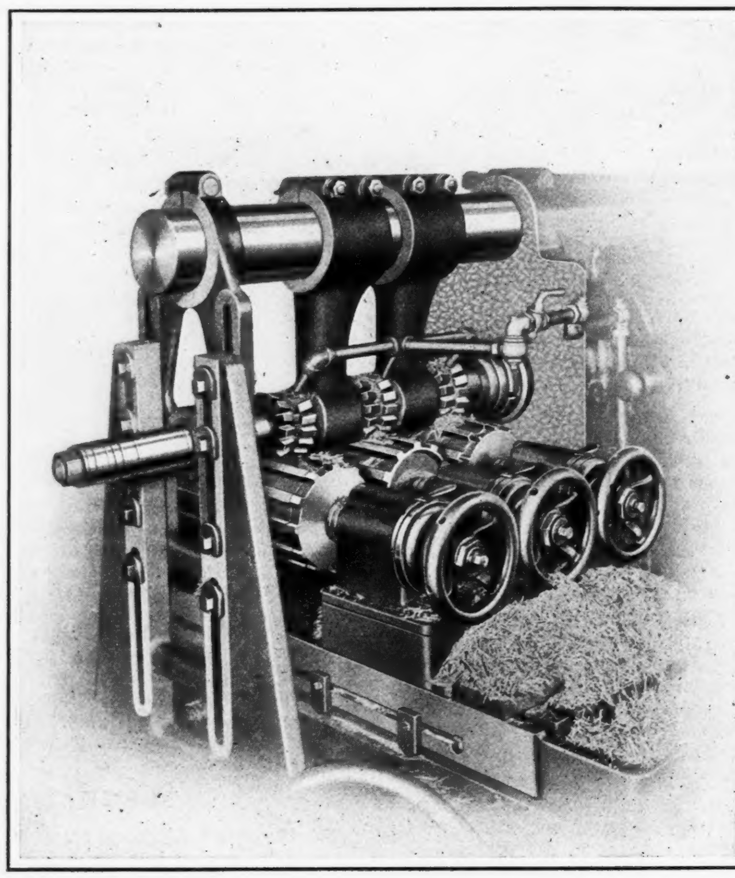
William Mason, who was for twenty-eight years master mechanic of the Winchester Repeating Arms Co., New Haven, Conn., died in Worcester July 18, aged seventy-six years. Mr. Mason retired from his position with the Winchester Repeating Arms Co. several years ago. He was a mechanical genius and inventor of note. More than 125 patents were granted him, most of them being for improvements in looms and weaving, steam pumps, bridge work, arms and ammunition, and machinery used in the manufacture of arms and ammunition. For years Mr. Mason was connected with the Remington Arms Co., at Ilion, N. Y., and later was superintendent of Colts Patent Repeating Arms Co., at Hartford, Conn., for sixteen years.

BERNHARD SCHUCHARDT

Bernhard Schuchardt, of Berlin, Germany, head of the well-known firm of Schuchardt & Schütte, died June 3, after a short illness at his residence in Grunewald, near Berlin. Mr. Schuchardt was for many years closely identified with the American machine tool industry which has lost in him a prominent character. He was born on November 17, 1855, in Cassel, Germany. After graduation from college he entered on a commercial career. In his early years Mr. Schuchardt went to England, and traveled extensively in foreign countries. In 1880, the firm of Schuchardt & Schütte was founded. From a small beginning this house developed with remarkable progress into a large enterprise well known all over the globe. This organization for introducing modern machine tools is not confined to Europe alone, but has been instrumental in opening up many foreign countries for this industry. In 1890 Mr. Schuchardt made his first trip to the United States. Recognizing the higher stage of development of the American machine tool industry of that time, he decided to exert all his energies to introduce and further the sale of its products abroad. Not only has the American machine tool industry been greatly benefited by his work, but also the important manufacturing centers all over the world through gaining knowledge of highly efficient American manufacturing methods. His firm opened branch houses in many foreign countries—Austria-Hungary, Great Britain, Sweden, Norway, Denmark, Russia, North and South America, China, Japan, etc. Mr. Schuchardt's life work was that of no ordinary man. So great an organization, unlimited by borders of countries or languages, could only have been built up by a great commercial genius of his type. He was, without a doubt, a pioneer in developing the machine tool export and import trade, and as such will long be remembered.

Bernhard Schuchardt

SIX CUTS AT ONCE



MILLING GROOVES IN SIX STEEL CORES AT ONE TRAVERSE

The cut shows an unusually heavy milling operation, consisting of cutting two grooves 1.17″ wide and 5-16″ deep in each of *six steel forgings* at one traverse of the table.

Three sets of heavy index centers are employed with two steel cores mounted on the arbor on each pair of centers.

Each set of cutters is formed to mill two grooves and the top of the intervening space between the grooves.

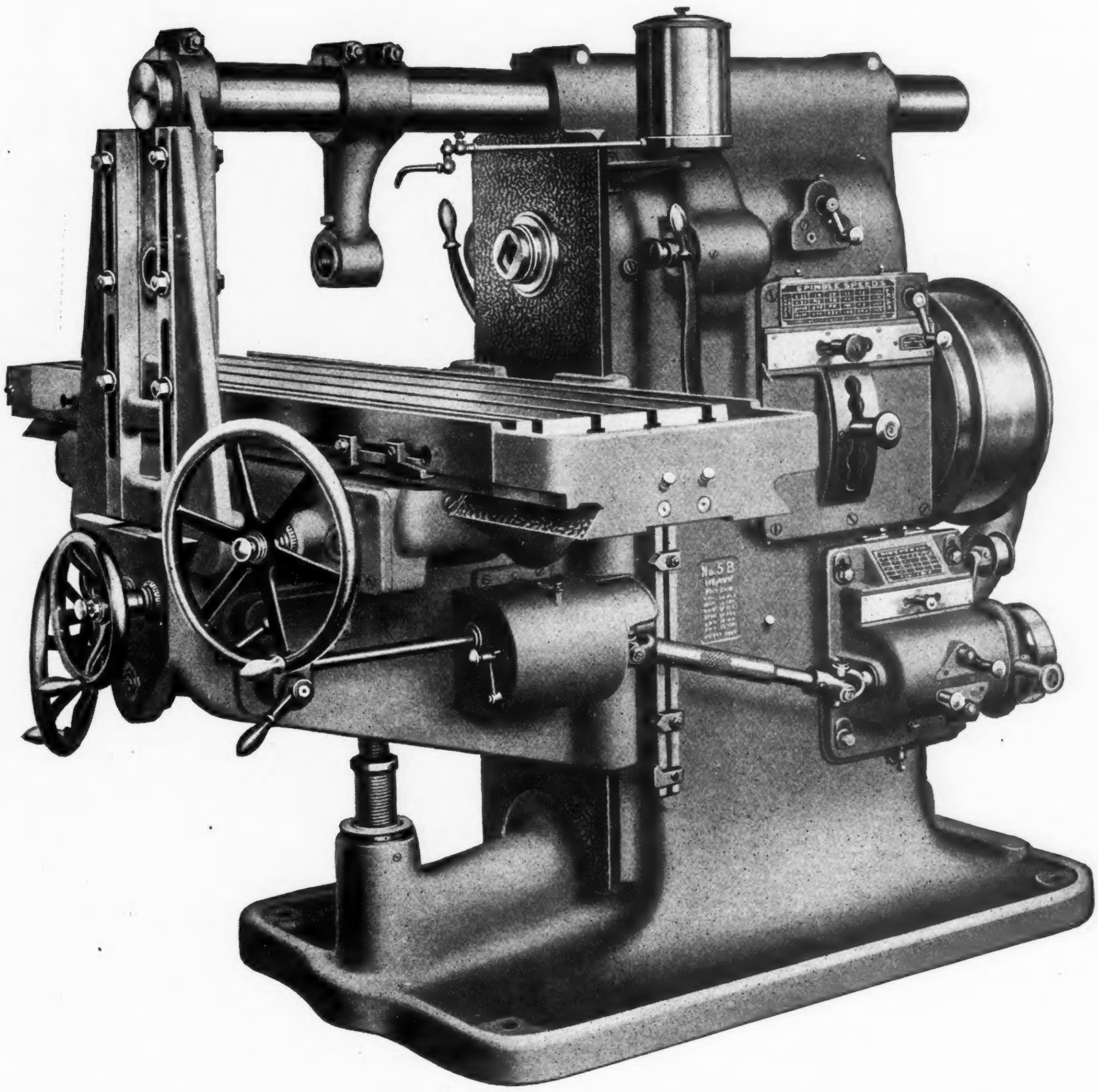
Note the B. & S. method of supporting the arbor under these extreme stresses, by unusually heavy arm braces and arbor supports which hold the arbor firmly in line and effectually prevent springing.

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

SHOWS AMPLE POWER



No. 5 B HEAVY PLAIN MILLING MACHINE

It is built for just such heavy cuts as these. Notice the extra deep table, giving unusual stiffness; the long bearing of the box form knee.

Recess, not slot, in spindle for driving arbors with clutch collars—complete ring of metal prevents spreading under heavy service.

The ample driving power is backed by consistently rigid design.

Capacity 50″ x 12″ x 21″.

Driving Pulley 20″ dia., runs 320 R. P. M., 7″ belt.

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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COMING EVENTS

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y. last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

SOCIETIES, SCHOOLS AND COLLEGES

University of Utah, Salt Lake City, Utah. Catalogue of the University, including school of arts and sciences, school of education, state school of mines, school of medicine and school of law, for 1913-14.

Pratt Institute, Brooklyn, N. Y. Circular of information on the School of Science and Technology, which offers courses in steam and machine design, applied electricity, applied chemistry, applied leather chemistry, machine construction, carpentry and building, tanning, technical chemistry, mechanical drawing, practical electricity, practical mathematics, strength of materials, carpentry and building, patternmaking, sheet-metal work, plumbing, advanced woodworking for teachers, etc. The practical value of the day courses offered in Pratt Institute is attested to by the fact that young men who have taken the course in past years have obtained good positions and with rare exceptions have advanced rapidly in their work. The circular shows views of the work in the mechanical laboratory, pattern shop, machine shop, electrical laboratory, etc.

Massachusetts Institute of Technology has established an electrical research laboratory and bureau, to be devoted to research and engineering investigation. An endowment of over $200,000 has been provided for electrical research and a grant of ten thousand dollars a year for five years has been made by the American Telephone & Telegraph Co. through its president, Theodore N. Vail. Mr. Vail believes that it is becoming more and more to the advantage of commercial firms to endow general research in the laboratories of institutions of education which are fitted to carry them on in an impartial manner. It is true that a great amount of commercial research has been carried on in institutional and private laboratories, but this has been limited to problems having obvious relationships to the firms carrying on the investigations. Mr. Vail believes in a research policy of wider scope, and the gift of his company leaves the direction in which the research shall be made entirely to the school.

NEW BOOKS AND PAMPHLETS

Report of the Commissioner of Education for the Year Ended June 30, 1912. Part I. 647 pages, 6 by 9 inches. Published by the Bureau of Education, Washington, D. C.

Report of the Commissioner of Education for the Year Ended June 30, 1912. Part 2. 669 pages, 6 by 9 inches. Published by the Bureau of Education, Washington, D. C.

Manual for Engineers. Compiled by Charles G. Ferris. 240 pages, 2¾ by 5½ inches. Published by the University of Tennessee, Knoxville, Tenn. Price, 50 cents.

This useful collection of tables and other data for engineers and business men, which was first issued in 1904, has passed into the eighteenth edition. This fact testifies to the general value of the work. In the new edition, instructions are given for procedure in case of electric shock, shop injuries, poisoning, etc. The contents include metric conversion tables; squares, cubes, square roots and cube roots; decimals of a foot for each 1-64 inch; weights and areas of square and round bars; tables of natural sines, tangents and secants; steam tables; tables of common and hyperbolic logarithms; earthwork tables; tables of horsepower of water wheels, etc.

Resuscitation From Electric Shock. By Charles A. Lauffer. 47 pages, 4 by 6½ inches. Published by John Wiley & Sons, New York City. Price, 50 cents.

This book by Dr. Lauffer, medical director of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., describes the mechanism of respiration and the steps necessary to revive a person who has suffered from electric shock, asphyxiation, inhalation of chloroform or ether, overdoses of laudanum, drowning, heavy blows in the solar plexus, etc. The prone pressure or Schafer method of resuscitation, adopted by the National Electric Light Association and a number of other engineering societies, is described in detail. The book is one that can be studied with profit by the responsible men of manufacturing plants in charge, such as foremen, gang bosses, superintendents, welfare directors and others who may have to direct the resuscitation of workmen in emergencies.

Traction Farming and Traction Engineering. By James H. Stephenson. 330 pages, 5¼ by 7½ inches. 150 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $1.50.

The application of the gasoline engine to produce power required on the farm, and the development of the gasoline farm tractor has naturally created a demand from agriculturists for books dealing with the mechanical principles and construction of gas engines. This work was written with the view of furnishing farmers and others with a simple and plain treatise on the subject of gas power. The work treats of the gasoline farm tractors, fuel consumption of gas engines, alcohol as fuel, kerosene as fuel for traction engines, balancing of engines, piston rings, valves, leaky pistons, cylinders, carbureters, ignition, vaporizing of fuel, cooling systems, lubrication, horsepower calculations, gasoline engine troubles, types of gasoline and oil farm tractors, water supply systems, electric light for farm homes, the science of threshing, types of threshing machines, etc.

Visit to Germany of the American Society of Mechanical Engineers on the Invitation of the Verein Deutscher Ingenieure, 1913. 171 pages, 4¾ by 7 inches. Illustrated. Folding map. Published by Verein Deutscher Ingenieure, Berlin N. W. 7, Charlottenstr. 43, Germany.

This attractive book descriptive of industrial Germany was published in honor of the visit of the American Society of Mechanical Engineers to Germany and the joint meeting in Leipzig with the Verein Deutscher Ingenieure. The principal cities visited and described are Hamburg, Leipzig, Dresden, Berlin, Dusseldorf, Cologne, Frankfort-on-the-Main, Mannheim, Heidelberg and Munich. The descriptive part of the book is printed in German and English, the German and English texts being on opposing pages. The same arrangement is followed in the detailed itinerary of the trip and the descriptive notes of the principal manufacturing concerns and engineering works on the route. The book is an example of the thorough and painstaking work which characterized the preparations for the comfort and entertainment of the American visitors.

Scientific American Reference Book, 1913. By Albert A. Hopkins and A. Russell Bond. 597 pages, 5½ by 7½ inches. Illustrated. Published by Munn & Co., Inc., New York City.

This book was compiled in response to the demand for information as evidenced by the many thousands of inquiries received every year by the editorial staff of the "Scientific American." These inquiries show the need of a compendium of useful information—a work containing facts not readily obtainable from any other source. The book is one that will be found invaluable by the business man whatever his line may be. The contents are divided into two parts, statistical and scientific. The statistical information comprises population and social statistics; farms, foods and forests; mines and quarries; manufactures; commerce; mercantile marine; railroads; the Panama Canal; telegraphs and cables; wireless telegraphy; telephone statistics of the world; post office affairs; patents, trademarks and copyrights; armies of the world; navies of the world and aviation. The scientific information deals with chemistry; astronomy

and time; meteorology; machine elements and mechanical movements; geometrical constructions; weights and measures.

Principles of Setting Out. By Alfred Parr. Introduction by C. H. Bulleid. 290 pages, 5½ by 8½ inches. 236 illustrations. Published by Longmans, Green & Co., New York City. Price, $2.50 net.

This practical work on laying out, setting up and machining operations is based on British workshop practice, but the general principles explained are, of course, of universal application. The book is designed principally for engineering students and apprentices and students in metal training schools, but mechanics generally should find a perusal of this work and study of some sections of considerable value. Among the subjects treated are: Measuring and measuring instruments; Johansson gages; laying out a high-pressure steam engine cylinder; laying out keyways and fitting keys; dividing in the lathe; lathe mandrels of various types; clamping arrangements; machine vises; design, construction and use of jigs; drilling machines; crank-pin turning machines; boring bars and cutters; setting up and boring an engine cylinder and bearings; slotting machines; shapers; laying out a four-jaw chuck; magnetic chucks; use of hand turning tools; cutting square threads; cutting V-threads; screw cutting and chasing with hand tools; notes on chucking operations; turret lathe work; gear cutting; various types of gear teeth; cutting speeds and feeds for gear cutting; etc.

Theory and Test of An Overshot Water Wheel. By Carl Robert Weidner. 136 pages, 6 by 9 inches. Published by the University of Wisconsin, Madison, Wis., as Bulletin No. 529. Price, 40 cents.

The experiments described were undertaken with the object of securing data on the performance of the modern type of overshot water wheel. Contrary to general impression, the overshot water wheel is by no means out of use. It is still extensively used in Europe and to a limited extent in the United States. The advantages of the overshot wheel are enumerated as follows: (1) High efficiency. (2) Adapatability to varying discharge. (3) Simplicity in construction. (4) Reliability. (5) Non-interference of operation on account of clogging with debris or ice. The efficiency of overshot wheels is high, the tests demonstrating that the efficiency may be as high as 90 per cent. The tests indicate that the economical field of the overshot wheel lies in power developments which range approximately between 2 and 30 second-feet discharge, with heads varying from 10 to 40 feet, corresponding to a maximum development of 75 horsepower. The paper reviews Bach's theory and design of the overshot water wheel, and describes the Wisconsin experiments in detail. A review is given of the experiments made by Smeaton, Franklin Institute and Morin. While the cost of the overshot water wheel is about double that of the turbine wheel, its special advantages within the limits of its practical application make it a desirable means of water power development for certain localities.

Safety: Methods for Preventing Occupational and Other Accidents and Disease. By Dr. William H. Tolman and Leonard B. Kendall. 432 pages, 6 by 9 inches. Illustrated. Published by Harper & Bros., New York City. Price, $3 net.

During the past decade a great change has taken place in the attitude of manufacturers, railway men and others connected with the various departments of industrial life toward accidents and their effects on business and society. Business men have awakened to a realization that a manufacturing or transportation business that neglects to provide proper safeguards for its employes is not a good business. A comprehensive book bearing on the practical aspect of accident prevention in manufacturing plants is bound to be, therefore, of much interest, and this book on safety meets the demand for a broad work on the general principles of safeguarding to be observed in manufacturing conditions. The work is divided into four main parts, viz.: General Conditions, Danger Zones, Industrial Hygiene and Social Welfare. It treats of the philosophy of safety, neglected factors, the working-place, danger zones such as yards, walks, railings, hoists, etc. Chapters are devoted to cutting and grinding tools, illumination, fire, iron and steel, mines and mining, electricity, general aids to safety, organized efforts by employers. The importance of industrial hygiene is fully recognized, four chapters being devoted to it. These are on general aspects of sanitation, industrial poisons, chemical industries and shop sanitation. The fourth and concluding portion of the book devoted to social welfare, is on industrial education, meeting the public, training future workers, welfare in after hours and the American Museum of Safety. Dr. Tolman has devoted years of his life to safety and welfare work and has done much to bring the movement prominently before the world. The work by him and his collaborator, Mr. Kendall, should be an effective means of promoting the movement for greater safety and sanitation.

Das Maschinen-Zeichnen. By A. R. Riedler, 234 pages, 8 by 11 inches. 436 illustrations. Published by Julius Springer, Berlin, Germany. Price, 10 marks.

This work on machine design and drawing is unique, in that it deals not so much with the individual details of machine construction as with the general principles met with in machine design, and with the proper methods of representing designs in drawings. In order to show clearly the methods to be used, the book is profusely illustrated with detail as well as assembly drawings of the most varied character. A feature of the book that especially deserves commendation is that in a great many instances two illustrations are shown side by side, one showing a wrong construction or objectionable method of drawing, while the other shows the correct or preferable design and method of representation in drawings. As examples may be mentioned illustrations showing correct and incorrect methods of dimensioning drawings; objectionable and recommended methods of indicating finished surfaces; correct and incorrect methods of arranging the different views of the drawing, so as to prevent misunderstanding on the part of the shop man; and many illustrations of correct and incorrect designs of machine details. The book deals exclusively with general principles and with the picturing of machine parts in drawings. It contains nothing relative to the methods of calculations or determining the dimensions in machine design. The book, of course, is in German; no doubt there would be a field for a book of this kind in English, and it should be especially useful in technical and engineering schools, as it would show the students in a clear and easily comprehended manner the fundamental principles and requirements in machine drawing and design. One somewhat objectionable feature in the present work is the typographical arrangement; the page is large and the text matter is printed in one long line across the page, making it difficult to read. The arrangement would have been decidedly better if the text had been printed in two columns to a page.

NEW CATALOGUES AND CIRCULARS

Gardner Governor Co., Quincy, Ill. Circular on duplex power pumps.

Reed & Prince Mfg. Co., Worcester, Mass. Leaflet on working gages for users of machine screws, nuts and taps.

Treadwell Engineering Co., West Street Bldg., New York City. Folder on Stoever pipe cutting, threading and bending machines.

Lea Equipment Co., Stenton & Wyoming Aves., Philadelphia, Pa. Bulletin on the Lea Simplex cold cutting-off saw, illustrating 1913 models.

Bristol Co., Waterbury, Conn. Bulletins 175, 176 and 178 on electrical resistance thermometers, model 162, electric pyrometers and wet and dry bulb recording thermometers, respectively.

Springfield Mfg. Co., Bridgeport, Conn. Circular of wet and dry ball bearing grinders. High-grade ball bearings are provided for the spindles, having capacities several times the load these bearings are ordinarily required to sustain.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet illustrating noteworthy examples of the benefits derived from "Cling-Surface" in five prominent railroad shops. The circular gives a list of forty railroads using "Cling-Surface" in their repair shop.

Norma Company of America, 20-24 Vesey St., New York City. Bulletins Nos. 102, 103, 104 on "Norma" ball bearing—combined annular and thrust bearings; roller bearings—combined roller and thrust bearings; single and double ball thrust bearings, respectively.

Electric Controller & Mfg. Co., Cleveland, Ohio. Pamphlet on the automatic control of machine tools, illustrating electrical equipment and applications to punching and coping machines, shapers, slotters, lathes, boring mills, milling machines, grinders, upright drills, etc.

Abbott-Schmidt Co., 328 McCormick Bldg., Chicago, Ill. Catalogue of edited engineering service, which includes a resume of articles dealing with any engineering subject published in technical and scientific journals in America, England and Colonies, France and Germany.

Fairbanks-Morse & Co. Inc., Chicago, Ill. Bulletins Nos. 25 and 35 on direct-current and alternating-current apparatus. Both bulletins are in catechism form and contain valuable technical data for users of electrical apparatus. A glossary is included covering all electrical terms used.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet on Cling-Surface for belts, showing its use the world over. Installations of "Cling-Surface" treated belts in Germany, England, Scotland, Ireland, Norway, Sweden, France, Spain, Switzerland, Belgium and other foreign countries, are shown.

Mark Mfg. Co., Chicago, Ill. Circular on the Mark cold-drawn steel union, a union made from sheet steel and faced on the female seat with brass. This union is free from the common defects of cast iron, malleable iron and brass unions; it has tapered threads which exactly fit the taper of pipe threads and is sherardized to prevent corrosion.

Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. Catalogue No. 2 on Armstrong drop-forged steel wrenches, comprising single open-head wrenches; double open-head wrenches; double-head S wrenches; square box wrenches; set-screw wrenches; toolpost wrenches; structural wrenches; wrenches in sets; socket wrenches; alligator wrenches; etc.

C. F. Pease Co., 166 West Adams St., Chicago, Ill. Catalogue of blueprint machinery, blueprint room supplies, direct white print machinery, drafting-room furniture, etc. This catalogue entitled "Everything for Blueprinting" shows a line of machinery for rapid blueprinting. It will be found of general interest to all who have to reproduce drawings, etc.

Davis-Bournonville Co., 30 Church St., New York City. Bulletin on the "Oxygraph," an oxy-acetylene flame apparatus for cutting steel according to pattern. This ingenious device is successfully used for cutting large openings in forgings, cutting the patterns of dies, and for many other kinds of work that ordinarily would require long and expensive machine operations to accomplish.

Ingersoll-Rand Co., 11 Broadway, New York City. Catalogue of Ingersoll-Rand products, comprising steam-driven air compressors, belt-driven air compressors, electrically-driven air compressors, gas compressors, gasoline extrusion compressors, air purifiers, vertical and horizontal after-coolers, air reheaters, steam pumps, rock drills, pneumatic hammers, drill sharpeners, oil furnaces, etc.

General Electric Co., Schenectady, N. Y. Bulletins A4035 on series luminous arc lamps; No. A4109 on belt-driven revolving armature alternators; A4114 on central station oil switches; A4121 on direct current motors, type CVC; A4123 on automatic voltage regulators; A4127 on combined straight and automatic air brake equipment; and A4129 on small feeder voltage regulators.

Standard Machinery Co., 7 Beverly St., Providence, R. I. Catalogue of wire drawing machinery, rotary swaging machines, rotary shears and other swaging machines applicable to the jewelry and machinery trades. This catalogue is one of five different sections of a general catalogue issued to show some departures from the standard line of wire drawing machinery as well as the company's regular lines.

Wiener Machinery Co., 50 Church St., New York City. Catalogue of Oeking solid steel frame triple and quadruple combination punch, shear and bar and angle cutters. These machines are adapted for notching, coping, mitering and cutting off channels, I-beams and angles. The catalogue also illustrates solid steel frame heavy gate shear and the "S. & N." rapid beam shears which will cut a 12-inch I-beam in seven seconds.

Ingersoll Milling Machine Co., Rockford, Ill. Pamphlet entitled "Not Stunts—Facts," illustrating the use of Ingersoll milling machines on gas engine work, machine tool parts, steam pump work, printing press parts, gasoline traction engine frames, woodworking machinery, locomotive work, etc. Data are given on the time of production, which makes the publication of unusual interest to mechanical men responsible for production.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Rail Report Bulletin No. 1. This report covers five consecutive sets of open-hearth steel rails rolled during the early part of 1913 for three different railway systems. The purpose is to place before railway officials the results of comparative tests of standard carbon steel rails and rails of the same general composition treated with titanium. This undertaking is one that should excite general interest in railway circles.

Green Fuel Economizer Co., Matteawan, N. Y. Circular of Green's conical flow fan which differs from both centrifugal and axial flow fans in that the air enters and passes through the fan and through the diffuser or stationary housing obliquely to the shaft. The claim is made that this construction increases air handling capacity with the given diameter of wheel and permits the rotors to be run at high speeds. These fans can be connected directly to standard electric motors and steam turbines.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular on duplex horizontal drills, illustrating a variety of styles and sizes designed for horizontal drilling. The advantages of simultaneously machining work from opposite directions on the same axis are pointed out. Facing is done in practically one-half the time consumed in single spindle operations and in perfect alignment. A variety of fixtures is furnished with these machines, making them especially adapted to the needs of automobile manufacturers, etc.

Cleveland Planer Works, 3150-3152 Superior Ave., N. E., Cleveland, Ohio. Catalogue of Cleveland open-side planers, illustrating details of design. Some of the details shown are: Top of bed, bottom of bed, knee, column, table, bull gear pinion and side gear, etc. The illustrations of planers include the following sizes: 30 inches by 30 inches by 8 feet; 36 inches by 36 inches by 12 feet; 42 inches by 42 inches by 12 feet; 48 inches by 48 inches by 14 feet; 60 inches by 60 inches by 14 feet; and 72 inches by 72 inches by 16 feet.

L. S. Starrett Co., Athol, Mass. Catalogue No. 20 of mechanics' fine tools, containing 320 pages. The new catalogue contains 46 more pages than the previous catalogue, the new matter comprising data and tables such as metric conversion tables, decimal equivalents, weight computing tables, tapers and angles, wire gage tables, etc., and new tools. The following new tools are listed: Six- and eight-foot straightedges, new attachment for combination squares, new caliper squares, twenty-four-inch vernier caliper, heavy micrometers, screw thread micrometers, tubing micrometer, micrometer head, hub micrometer, soft leather cases for micrometers, bench micrometer, vernier depth gage, new hack-saws and new type of calipers.

National Machinery Co., Tiffin, Ohio. Booklet entitled "Perfect Threads," illustrating the National opening die head and interchangeable case die which were demonstrated at the late conventions of the American Railway Master Mechanics and Master Car Builders at Atlantic City under unusually difficult conditions. The demonstrations were made on the company's double, triple and quadruple bolt cutters. Threads were cut on stay-bolts having very pronounced humps and on tapered bolt blanks. Tests failed to show any difference in the diameters or shapes of the threads cut under the humped portions as compared with those cut under the normal sections of the specimens. The booklet illustrates the double, triple and quadruple bolt cutters, motor-driven, and the company's plant in Tiffin, Ohio.

Nicholson File Co., Providence, R. I. Booklet entitled "File Filosophy," containing useful hints on the proper methods of using files and the various

applications of the most common files. This booklet has passed through seven editions and upwards of fifty thousand copies have been distributed. The work includes the most important parts of the "Treatise on Files," written by William T. Nicholson, founder of the Nicholson File Co., in 1878. It is used in the mechanical engineering courses of a number of the leading colleges and institutions, in manual training schools and by the supervisors of apprentices of several railroads and large manufacturing plants as a textbook on files and filing. The eighth revised edition is typographically attractive. The contents comprise definitions of terms, hints and suggestions as to the proper method of using files, file handles, illustrations of various cuts, names of files with illustrations, etc.

TRADE NOTES

Boston Gear Works, Norfolk Downs, Mass., will shut down for annual vacation and repairs August 15 to August 25.

Bowman-Blackman Machine Tool Co., St. Louis, Mo., dealer in machine tools, has removed to its new building, 1413 North Broadway.

Noble & Westbrook, 9 Asylum St., Hartford, Conn., makers of stamping dies, the Dwight Slate marking machine, etc., have changed their firm name to the Noble & Westbrook Mfg. Co.

Taylor & Fenn Co., Hartford, Conn., has purchased from the Whitney Mfg. Co., Hartford, Conn., the drawings, patterns and good will of the Whitney twenty-inch water tool grinder.

Lockwood, Greene & Co., 60 Federal St., Boston, Mass., architects and engineers for industrial plants, have removed their New York offices from 320 Fifth Ave. to the Architects' Bldg., 101 Park Ave. The New York representatives of the concern are Frank A. Wing and John M. Toucey.

Superior Tap Co., Charlestown, N. H., is now manufacturing the Remington two-piece thread die, formerly made by the Remington Tool & Mfg. Co. The leading feature of this die is that it may be readily separated for grinding the lands—an impossibility with the solid die. The Superior Tap Co. will manufacture this die in six sizes.

American Pulley Co., Philadelphia, Pa., has moved its New York branch from 203 Lafayette St., into more commodious quarters at the corner of Grand and Greene Sts. A complete stock of "American" belt pulleys will be carried at the new address, and orders will be taken for reels, spools, beams, sash pulleys and pressed steel shapes.

H. W. Johns-Manville Co., Madison Ave. and Forty-first St., New York City, recently opened a branch office at Charleston, N. C. The new company is located in the Commercial Bank Bldg. and is in charge of Mr. E. U. Heslop, who is assisted in covering the western section of North Carolina by P. J. McCusker and Paul W. Whitlock.

Winkley Co., Detroit, Mich., has purchased the entire bolt and automobile grease cup departments of the Penberthy Injector Co., of Detroit, including machinery and good will. The Winkley Co. will continue to manufacture and maintain the high-grade character of these goods. Mr. Alexander E. Pribil, mechanical engineer, who had charge of these departments for the Penberthy Injector Co., will continue in the same capacity with the Winkley Co.

Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa. (Samuel S. Eveland, owner), has sold the entire production of the electric riveters of the factory, having an approximate value of $1,500,000 for the first year, to Manning, Maxwell & Moore, Inc., 85 Liberty St., New York City. The Eveland Engineering & Mfg. Co. is installing a large amount of new machinery to increase its output, and will manufacture transformers and electrical tempering and hardening machines as well as the Eveland electric riveters.

Catskill Foundry & Machine Works, Catskill, N. Y., recently purchased from the owners, the patterns, blueprints and drawings, also the stock of manufactured parts for the Corliss engines built by the Fishkill Landing Machine Co., Fishkill-on-Hudson, N. Y., and succeed to the business of making and furnishing repairs for this well-known line of stationary engines. George B. Van Tine, formerly superintendent of the Fishkill concern, goes with the Catskill Foundry & Machine Works, and will give personal attention to the engine work.

E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has let contracts for a new erecting shop 200 feet long by 129 feet wide. The building will be of steel construction faced with brick and of one story with mezzanine gallery for machinery. Two 40-ton Shaw cranes of 80-foot span and one 15-ton Shaw crane of 41-foot span will be installed. The head room under the roof trusses will be 44 feet and over the erecting pits the cranes will have a head room of 44 feet. The addition will be built to meet the increasing demands for the company's large presses.

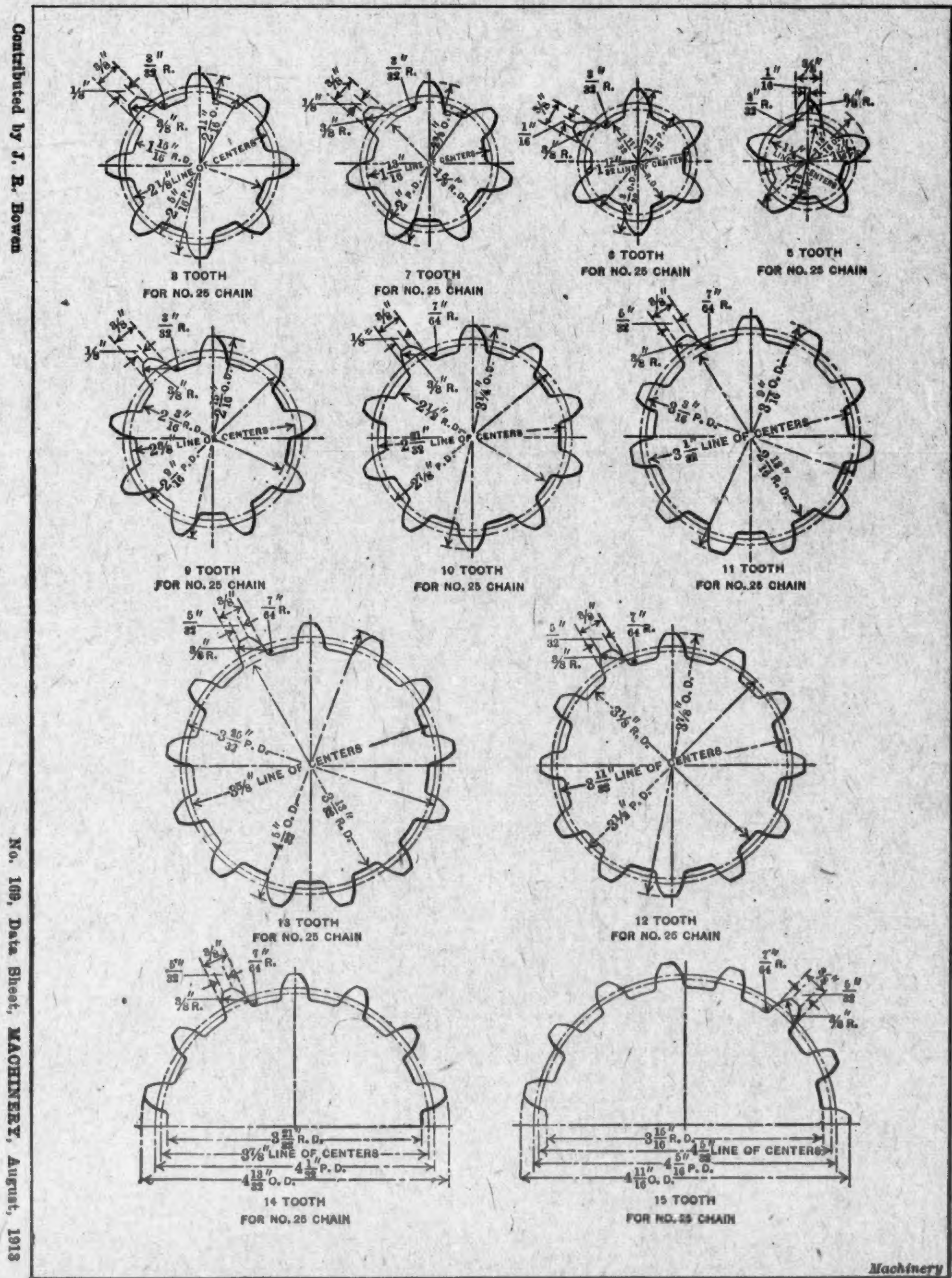
Whitney Mfg. Co., Hartford, Conn., has made plans for building another concrete addition to its factory. The addition is to be 60 feet wide, 112 feet long and four stories high, making an addition of 26,880 square feet of floor space. The recently completed two-story building 50 by 180 feet is being equipped with machinery, etc. The company has sold its twenty-inch water tool grinder to the Taylor & Fenn Co. of Hartford, Conn., and will now devote its entire attention to the manufacture of high-grade driving chains, keys and cutters for the Woodruff system of keying, and hand-feed milling machines.

Miscellaneous Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

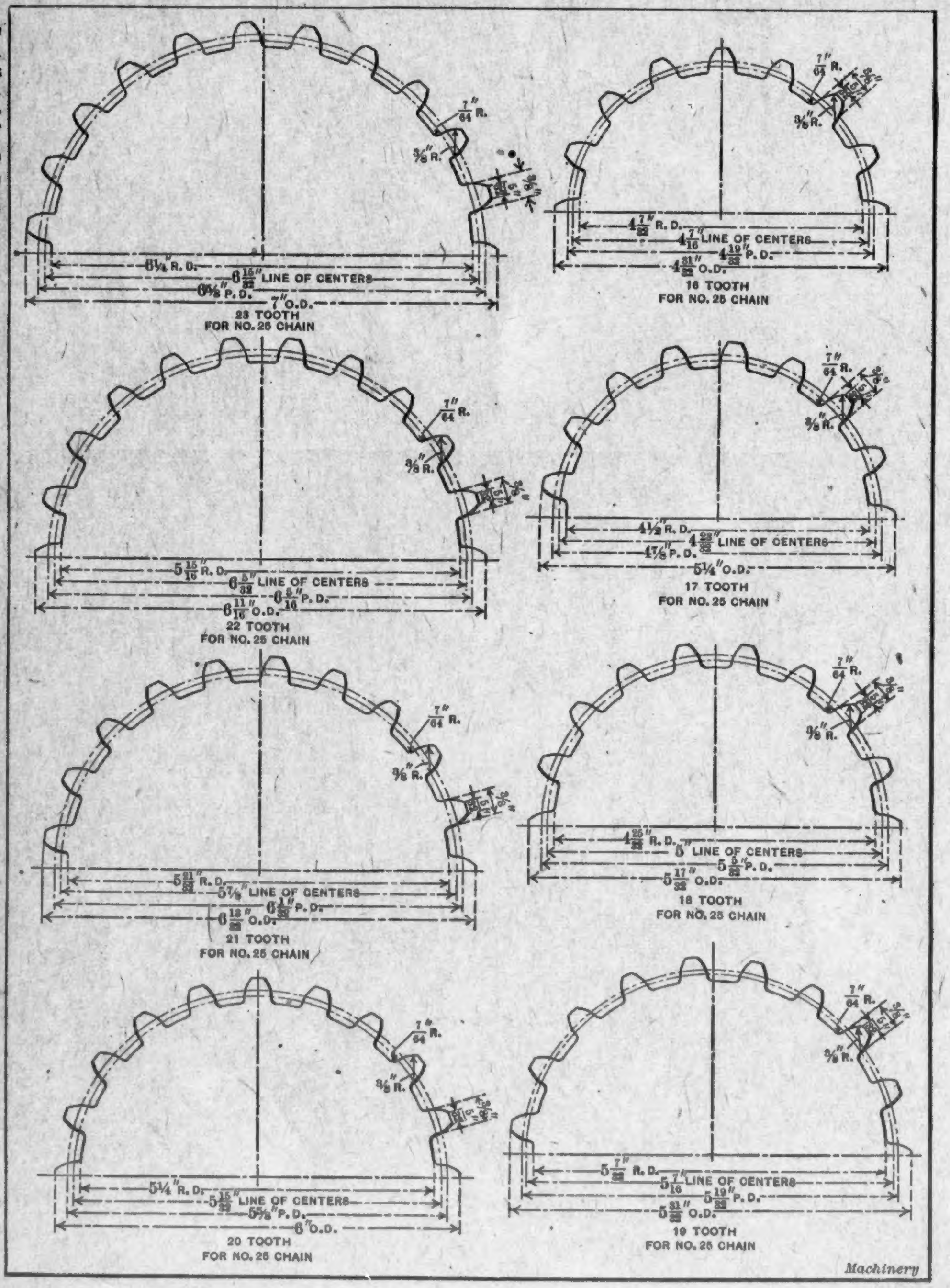
Tables and diagrams for article in this number entitled "Sprock

SPROCKETS FOR DETACHABLE LINK BELT—I



Contributed by J. R. Bowen

SPROCKETS FOR DETACHABLE LINK BELT—II

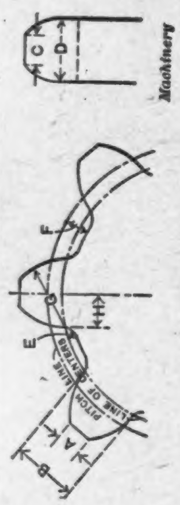


Contributed by J. R. Bowen

SPROCKETS FOR DETACHABLE LINK BELT—III

SPROCKETS FOR DETACHABLE LINK BELT—IV

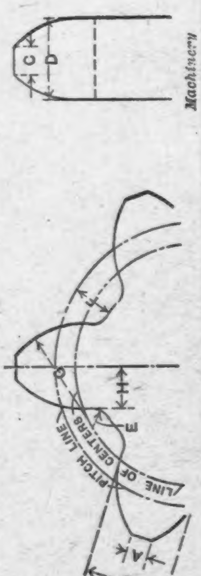
SPROCKETS FOR DETACHABLE LINK BELT—III



Chain No.		Number of Teeth 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
25	Pitch diameter	1 7/16	1 23/32	2	2 5/16	2 9/16	2 7/8	3 3/16	3 1/2	3 25/32	4 1/32	4 5/16	4 19/32	4 7/8	5 5/32	5 13/32	5 5/8	6 1/32	6 5/16	6 5/8
	Outside diameter	1 13/16	2 3/32	2 3/8	2 11/16	2 15/16	3 1/4	3 9/16	3 7/8	4 5/32	4 13/32	4 11/16	4 31/32	5 1/4	5 17/32	5 21/32	6	6 13/32	6 11/16	7
	Root diameter	1 1/16	1 11/32	1 5/8	1 15/16	2 3/16	2 1/2	2 13/16	3 1/8	3 13/32	3 21/32	3 15/16	4 7/32	4 1/2	4 25/32	5 7/32	5 1/4	5 21/32	5 15/16	6 1/4
	Line of centers	1 1/2	1 17/32	1 13/16	2 1/8	2 3/8	2 11/16	3 1/32	3 11/32	3 5/8	3 7/8	4 5/32	4 7/16	4 23/32	5	5 7/16	5 15/32	5 7/8	6 5/32	6 15/32
	Width at point = A.	1/16	1/16	1/8	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Width on P. D. = B.	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Thick. at point = C.	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
	Thick. at root = D.	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Radius E	3/32	3/32	3/32	3/32	3/32	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64
	Height F	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
	Radius G	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Dimension H	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
32	Pitch diameter	1 13/16	2 3/16	2 9/16	2 15/16	3 13/32	3 11/16	4 1/32	4 13/32	4 25/32	5 5/32	5 1/2	5 27/32	6 1/4	6 5/8	6 31/32	7 11/32	7 23/32	8 3/32	8 15/32
	Outside diameter	2 1/4	2 5/8	3	3 3/8	3 27/32	4 1/8	4 15/32	4 27/32	5 7/32	5 19/32	5 15/16	6 9/32	6 11/16	7 1/16	7 13/32	7 25/32	8 5/32	8 17/32	8 29/32
	Root diameter	1 3/8	1 3/4	2 1/8	2 1/2	2 31/32	3 1/4	3 19/32	3 31/32	4 11/32	4 23/32	5 1/16	5 13/32	5 13/16	6 3/16	6 17/32	6 29/32	7 9/32	7 21/32	8 1/32
	Line of centers	1 7/16	1 13/16	2 9/32	2 21/32	3 1/8	3 3/8	3 23/32	4 3/32	4 15/32	4 13/16	5 5/32	5 1/2	5 29/32	6 5/16	6 5/8	7 1/16	7 13/32	7 13/16	8 5/32
	Width at point = A.	1/8	1/8	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Width on P. D. = B.	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
	Thick. at point = C.	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Thick. at root = D.	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32
	Radius E	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Height F	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32
	Radius G	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
	Dimension H	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32
42	Pitch diameter	2 3/16	2 5/8	3 1/16	3 1/2	3 15/16	4 3/8	4 13/16	5 1/4	5 11/16	6 1/8	6 9/16	7	7 7/16	7 7/8	8 5/16	8 3/4	9 3/16	9 5/8	10 1/16
	Outside diameter	2 13/16	3 1/4	3 11/16	4 1/8	4 9/16	5	5 7/16	5 7/8	6 5/16	6 3/4	7 3/16	7 5/8	8 1/16	8 1/2	8 15/16	9 3/8	9 13/16	10 1/4	10 11/16
	Root diameter	1 9/16	2	2 7/16	2 7/8	3 5/16	3 3/4	4 3/16	4 5/8	5 1/16	5 1/2	5 15/16	6 3/8	6 13/16	7 1/4	7 11/16	8 1/8	8 9/16	9	9 7/16
	Line of centers	1 29/32	2 3/8	2 13/16	3 1/4	3 23/32	4 5/32	4 19/32	5	5 7/16	5 7/8	6 3/8	6 13/16	7 1/4	7 11/16	8 1/8	8 9/16	9	9 7/16	9 7/8
	Width at point = A.	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Width on P. D. = B.	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
	Thick. at point = C.	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Thick. at root = D.	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Radius E	11/64	3/16	3/16	3/16	13/64	13/64	13/64	3/16	3/16	3/16	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32
	Height F	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Radius G	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
	Dimension H	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16

Contributed by J. R. Bowen

SPROCKETS FOR DETACHABLE LINK BELT—IV



Chain No.		Number of Teeth 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
52	Pitch diameter	2 5/8	2 7/8	3 3/8	3 13/16	4 5/16	4 13/16	5 1/4	5 3/4	6 3/16	6 3/4	7 3/16	7 5/8	8 1/8	8 5/8	9 1/8	9 9/16	10 1/16	10 9/16	11
	Outside diameter	3 1/16	3 9/16	4 1/16	4 1/2	5	5 1/2	5 15/16	6 7/16	6 7/8	7 5/16	7 7/8	8 5/16	8 13/16	9 5/16	9 13/16	10 1/4	10 3/4	11 1/4	11 11/16
	Root diameter	1 11/16	2 3/16	2 11/16	3 1/8	3 5/8	4 1/8	4 9/16	5 1/16	5 1/2	6	6 1/2	6 15/16	7 7/16	7 15/16	8 7/16	8 7/8	9 3/8	9 7/8	10 5/16
	Line of centers	2 1/16	2 17/32	3 1/8	3 9/16	4 1/16	4 9/16	5	5 1/2	5 15/16	6 13/32	7	7 13/32	7 31/32	8 13/32	8 29/32	9 11/32	9 27/32	10 11/32	10 25/32
	Width at point = A.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Width on P. D. = B.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at point = C.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at root = D.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Height F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius G	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dimension H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	Pitch diameter	2 5/8	3 3/32	3 5/8	4 1/8	4 5/8	5 1/8	5 11/16	6 3/16	6 21/32	7 1/8	7 5/8	8 1/8	8 21/32	9 1/8	9 19/32	10 1/16	10 9/16	11 1/16	11 1/2
	Outside diameter	3 1/4	3 23/32	4 3/16	4 11/16	5 3/16	5 11/16	6 3/8	6 7/8	7 11/32	7 13/16	8 5/16	8 13/16	9 5/16	10	10 3/8	11 3/32	11 5/16	12 3/32	12 5/16
	Root diameter	1 7/8	2 13/32	2 15/16	3 3/8	3 15/16	4 3/8	5	5 1/4	5 25/32	6 5/16	6 27/32	7 5/16	7 13/16	8 5/16	8 7/8	9 1/4	9 27/32	10 5/32	10 25/32
	Line of centers	2 1/8	2 23/32	3 5/16	3 15/16	4 3/8	5	5 13/32	5 15/16	6 13/32	7	7 5/16	7 31/32	8 1/8	9 3/16	9 9/16	10 1/8	10 3/8	11 1/4	11 23/32
	Width at point = A.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Width on P. D. = B.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at point = C.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at root = D.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Height F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius G	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dimension H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	Pitch diameter	2 5/8	3 5/32	3 11/16	4 7/32	4 3/4	5 5/16	5 13/16	6 3/16	6 7/8	7 3/8	7 7/8	8 7/16	8 15/16	9 1/2	10	10 1/2	11 1/16	11 9/16	12 1/8
	Outside diameter	3 5/16	3 31/32	4 1/2	5 1/32	5 9/16	6 1/8	6 5/8	7 1/8	7 11/16	8 3/16	8 11/16	9 1/4	9 3/4	10 5/16	10 13/16	11 5/16	11 7/8	12 3/8	12 15/16
	Root diameter	1 13/16	2 11/32	2 7/8	3 13/32	3 15/16	4 1/2	5	5 1/2	5 31/32	6 9/16	7 1/16	7 5/8	8 1/8	8 11/16	9 3/16	9 11/16	10 1/4	10 3/4	11 5/16
	Line of centers	2 11/32	2 7/8	3 7/16	4	4 7/16	5 5/32	5 21/32	6 5/32	6 21/32	7 7/32	7 23/32	8 9/32	8 25/32	9 11/32	9 27/32	10 11/32	10 27/32	11 13/32	11 29/32
	Width at point = A.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Width on P. D. = B.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at point = C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Thick. at root = D.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Height F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Radius G	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dimension H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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